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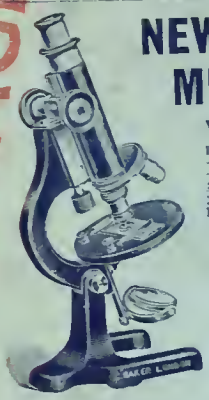

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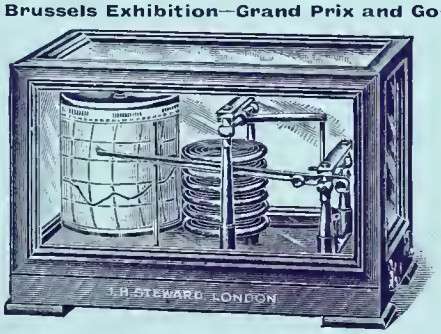

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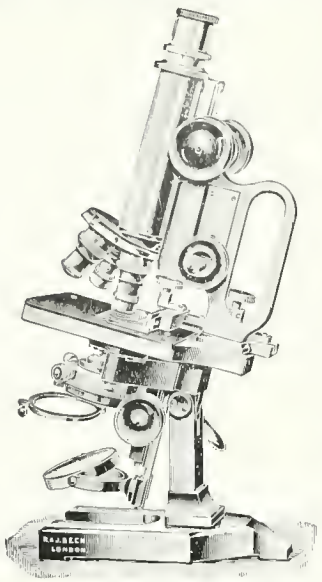

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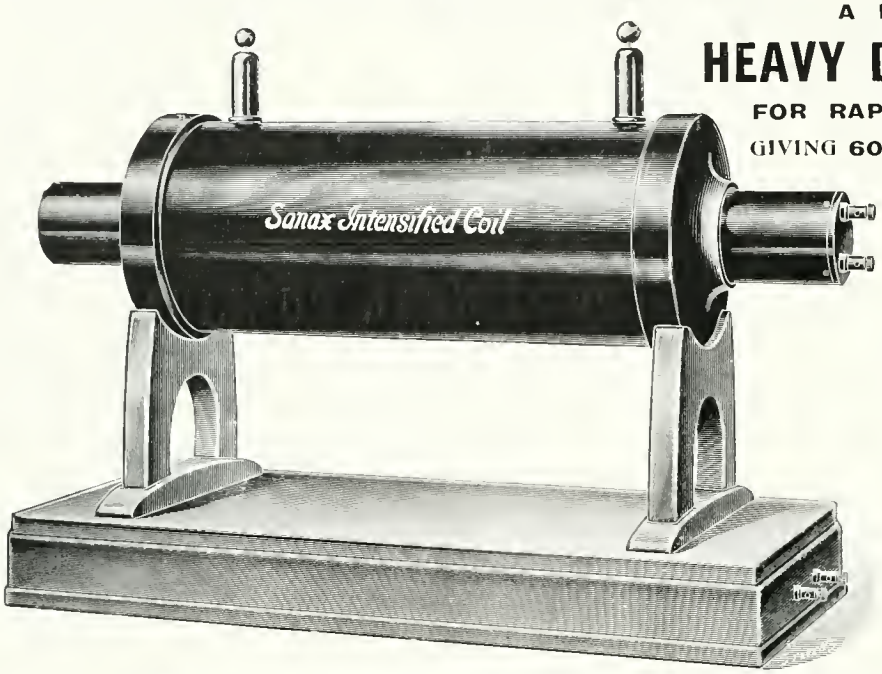

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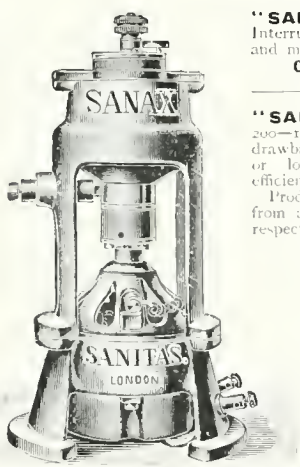

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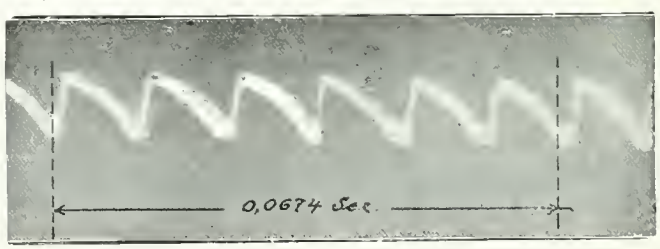

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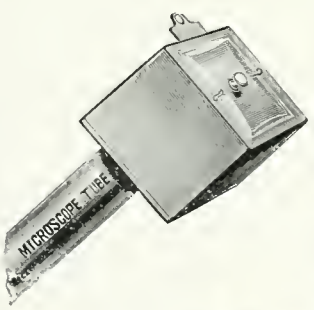

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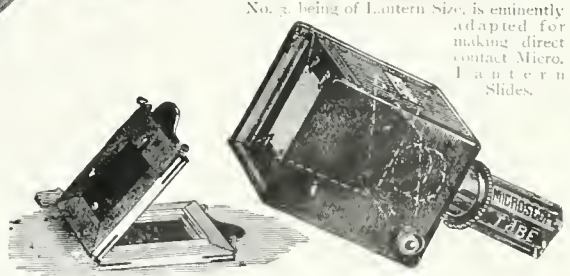

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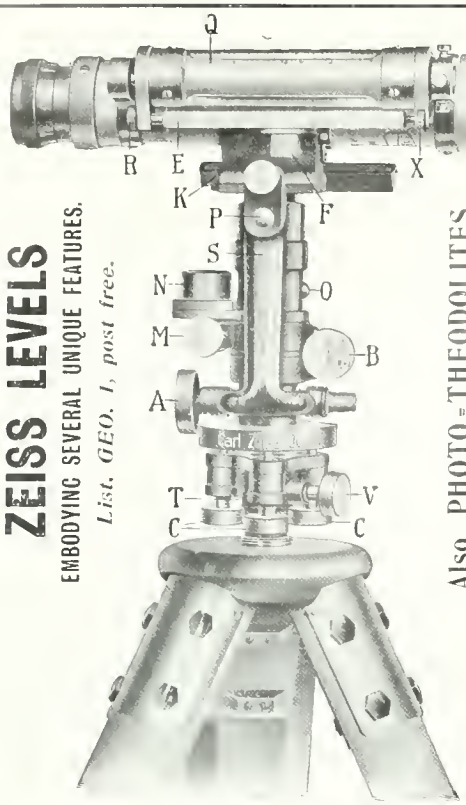

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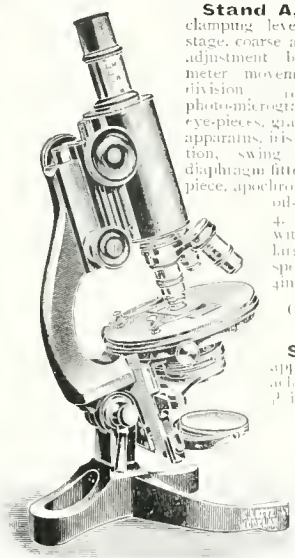

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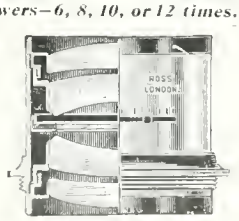

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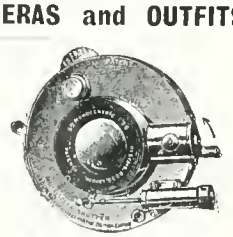

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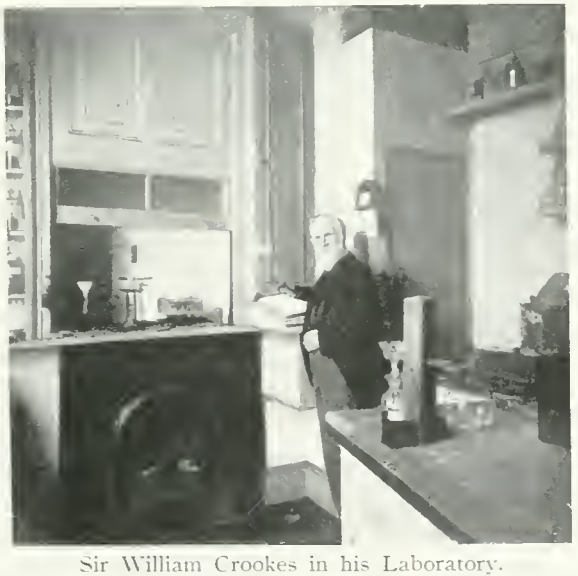
SIXTY YEARS OF CHEMICAL PROGRESS.

By E. S. GREW, M.A.

LAST month (Friday, November 11th), the Chemical Society held for the third time in its history a Jubilee Banquet, entertaining thereat, as guests of the evening, Professor William Odling, F.R.S., Sir William Crookes, O.M., F.R.S., Dr. Hügo Müller, F.R.S., and Dr. A. G. Vernon Harcourt, F.R.S. The fifth guest, Sir Henry Roscoe, F.R.S., who, like the other four, has been a President of the Society and a member of it for fifty years, was, unfortunately, unable to be present.



Sir William Crookes in his Laboratory.

It is nearly seventy years since the Chemical Society was founded (on March 30th, 1841), and its two previous Jubilee Banquets commemorated its foundation and the granting of its Royal Charter of Incorporation by Queen Victoria, on November 2nd, 1848. At the first of these banquets, Dr. W. J. Russell, F.R.S., who died a year ago (November 12th, 1909), presided: and among the speakers on that occasion were the late Marquis of Salisbury and the late Lord Playfair. At the second Jubilee Banquet no fewer than six of its past Presidents who had been members of the Society for fifty years were the guests of the evening. Their names were Professor J. H. Gilbert (of the Rothamsted experiments), Sir Edward Frankland, Professor William Odling, Professor A. W. Williamson, Sir Frederick Abel, and Dr. J. Hall Gladstone. Lord Playfair was to have been the remaining guest—the first in point of seniority: but he died before the Banquet took place, and it was postponed from June to November in consequence. At the time of his death, in June, 1898, he was the last survivor of the seventy-seven chemists who had joined the Society as original members on its foundation.

Of the other past Presidents at that banquet, all now are dead, except Professor Odling, whose perennial youth of spirit, may, we hope, preserve him to science and education for years to come. Professor Odling was born in 1829, and is still Waynflete Professor of Chemistry at Oxford University. He has made his mark as a teacher and as a philosophic chemist of the highest rank: and he is known throughout

the world as a chemist who has always been in the highest degree accessible to new ideas. No one has done more than he to champion the modern development of Chemical Theory: and the words which Sir James Dewar spoke of him twelve years ago are as true to-day. "Everyone must admit," said Sir James Dewar, "the debt of gratitude we owe him for his iconoclastic labours in clearing out old and vague notions, and for the courageous manner in which he has supported the newer ideas of his time."

Sir Henry Roscoe's fame as a teacher of chemistry is world-wide. His tenure of the Professorship of Chemistry at Owens College, Manchester, did more than anything else to elevate that institution, and the University of Manchester by which it was succeeded, to its present position as the foremost School of Chemistry in Great Britain. Sir Henry has always laboured to establish what we may perhaps describe as the official recognition of Chemistry: his benefactions to Chemical Institutions—and not least to the Chemical Society and its Library—have been great and numerous. His work on the relation of Chemistry to Public Health, and his researches on the Atomic Weight of Carbon, on Vanadium, and in Spectrum analysis have given him a place of the highest rank among chemists.

Sir William Crookes, O.M., Foreign Secretary of the Royal Society, is a chemist whose work has extended from the domains of pure chemistry and industrial chemistry to that of physical chemistry, and has been of the greatest significance to physics and the fundamental physical conceptions of matter. It is sufficient to enumerate some of his investigations to indicate the range of his work. His discovery of Thallium, in 1861, was one of the first-fruits of the then new science, spectrum analysis; his researches in the rare earths and the genesis of the elements have followed in logical sequence. Physics will always commemorate him for the "radiant matter," the "fourth state of matter," to which he was the first to give these cognomens; and his "Radiometer" and "Spinthariscope," toys though they have been said to be, have none the less furnished material illustrations of the fundamental relations of matter and energy.

Dr. Hügo Müller was the only one of the five guests who was not born a Londoner. He was born at Tirschenreuth in Bavaria, and he is one of several great Anglo-German chemists whose discoveries have been at the service of his adopted country. His early researches on the replacement of hydrogen and chlorine are the basis of much of the modern synthetic methods. His work on cellulose and on other subjects produced by plants is of the highest importance. It has been said of him that what he does not know regarding the chemistry of paper is not worth knowing. He is even better known as a mineralogist than as a chemist, and some of his modes of extracting, from minerals, products valuable in medicine are models of simplicity and accuracy—as in the extraction of lithium salts from triphylline.

Dr. A. G. Vernon Harcourt is well known to Oxford men as one of the most enthusiastic teachers of Chemistry who ever laboured in that University, and his researches on the *rate* of chemical change marked an epoch in philosophical chemistry. In more utilitarian fields, his publications on Chemistry, on Education, on Coal Gas, and Photometry, on Chloroform and its analysis, and its safe administration as an anaesthetic have added to the fame of the Oxford School of Chemistry, as well as to his individual reputation.

But that, perhaps, which is most impressive and conspicuous at a banquet of this kind is less individual achievement than the conception of the accumulated knowledge during the period which has been covered by the work of the chemists. In the sixty years of their joint experience the faces of chemical theory and of chemical practice have alike been changed. It would be impossible in the space of one article to summarise with even approximate adequacy the features of chemical progress in sixty years: but a very brief sketch of the change has been tentatively furnished by Professor Odling himself. The greatest change of all has been in the advance of the theories of chemical constitution. Following on the accepted theories of Dalton came the doubts awakened by newer investigations, and the assumptions which had to be made to reconcile theory with investigations. Laurent and Gerhardt working at the relative reacting unit weights of bodies; Liebig with his compound radicles: the work of Dumas in chlorine solutions; Graham's researches on the polyacidic acids; Williamson on the compound ethers: Wurtz and Hoffman on the compound ammonias; and the extension by Canizzaro of the work of Wurtz, were all steps in the stairway which led to a clearer comprehension of the units of chemical constitutions and their types. Thereafter the air was further cleared by Frankland's poly-combinations and Gerhardt's types of dissociation. The revision of the atomic weights led through Newland to Mendeleef—and to Mendeleef's conception of the table of the elements. Lyon Playfair and Kekulé carried the work on till Lebel and Van t' Hoff furmulated the doctrines of isomerism and rotating polymerisation. . . . Each of these men is a link in a great chain; but the work they do is never-ending, and on it can never be written the word "Finis."

That is true of any chemical researches: yet, if we were to seek in a review of chemical progress over sixty years for positive features they would be easily found in the work done by those who—from Berthelot to Emil Fischer—have pursued the synthesis of organic bodies: and in the great branches of knowledge which have sprung from the parent growth of chemical dissociation—such as the fundamental doctrines of Ampère and Avogadro; the theory of solutions; electrolysis; and the state of matter at high temperatures with its corollary of spectrum analysis.

INTERNATIONAL UNION FOR COÖPERATION IN SOLAR RESEARCH.

By W. SHACKLETON, F.R.A.S., A.R.C.S.

THE fourth Conference of the International Union for Coöperation in Solar Research was held at the Solar Observatory of the Carnegie Institution, Mount Wilson, California, from Aug. 30th to Sept. 3rd, and several representatives from this country were present. Previous conferences have been held at St. Louis, Oxford and Paris. The meetings are now triennial, and the next is arranged to take place in Germany.

Great Britain was represented by Rev. A. L. Cortie, S.J., Professor F. W. Dyson, Professor A. Fowler, Major E. H. Hills, Sir Joseph Larmor, Professor H. F. Newall, Professor A. Schuster and Professor H. H. Turner. Other distinguished astronomers and physicists from Germany, Russia, France, Austria, Holland, Italy, Switzerland and Sweden were also present, together with a large gathering of the American astronomers.

The proceedings of the conference consisted of the discussion of the reports of the various committees appointed at the previous conference, at Meudon, in 1907, to investigate solar radiation, sun spots, solar rotation and standards of wave-length. The International Eclipse Committee also met, and a new committee was appointed to consider the important subject of the classification of stellar spectra, as, obviously, solar research can be materially assisted by a study of the many stars with which it is so intimately related spectroscopically.

These proceedings, when published, will form the third volume of the "Transactions of the International Union for Coöperation in Solar Research."

En route to Mount Wilson Solar Observatory many of the astronomers took part in the meeting of the Astronomical and Astrophysical Society of America. This Society meets once a year, as American astronomers are scattered over the whole of the continent, and cannot readily meet at shorter intervals, the selected place of meeting of the Society this year being Harvard College. Here several papers on Halley's comet were read by Professor Barnard and others, together with a paper on the results of the Society's expedition to Hawaii to observe the comet. These were supplemented by a paper from Professor Fowler, on the "Spectroscopic Features of the Head and Tail of Comets." This paper elicited some discussion and received warm approbation.

FIGURE 1.

Tower Telescope, Solar Observatory, Mount Wilson, California.

Another interesting paper was read by Mr. Joel Stebbins on "The Measurement of the light of Stars with a Selenium Photometer, and its application to the variations of Algol." He showed that Algol has a second minimum, and that the light curve between the two minima is not flat. The results derived from this research indicate that the dark companion to Algol is not black, but gives off more light than the Sun.

The observatories at Harvard College, under the Directorate of Professor Pickering were thrown open to inspection: it may be mentioned that the 5-foot reflector formerly belonging to the late Dr. Common forms a part of the equipment of this observatory.

During the week preceding the Conference many of the party crossing from East to West visited the Flagstaff Observatory, Arizona, where Professor Lowell personally welcomed the astronomers, and showed many of his photographs and drawings of Mars.

On arrival at Pasadena the physical laboratory, workshops and computing establishment were inspected, the astronomers then gradually made their way up the mountain trail to the summit of Mount Wilson (altitude 5,886 feet), where the observing portion of the observatory is situated.

Beyond extending a hearty welcome to the

numerous delegates and giving a short address. Professor Hale, unfortunately, was unable, on account of illness, to take an active part in the meetings. In his address he spoke of the use of the Conferences and of their stimulation to research: also on the needs of tertiary standards, and the preparation of a spectrum map on a large scale. He also spoke of the new tower telescope and combined spectrograph and spectroheliograph, illustrated in this article.

FIGURE 2.

July 17, 1905, $17^h\ 56^m$. Low-Level Calcium Flocculi Slit Set on H_1 (λ3966). Sun's Diameter = 0.28 meter.

The sessions of the Conference then formally began, and the reports of the various committees were received.

The report of the Executive Committee was given by Professor Schuster.

Professor Kayser presented the report of the Committee of wave lengths, suggesting the adoption of three hundred and seventy-one standard wave lengths, mostly of the iron spectrum.

Mr. Abbott presented the report on the measurement of Solar radiation. The most probable value of the Solar Constant of radiation appears to be about 1·92 calories per square c.m. per minute.

Professor Fowler presented the report of the committee of Sun-spot observations, one result of which is, that the spot spectrum is found to be as constant as the Fraunhofer spectrum itself.

Professor Newall spoke of the possibility of using plane gratings for measuring the wave lengths of tertiary standards, whilst Professor Fabry said, that for short portions of the spectrum plane gratings may be even better than concave gratings.

Mr. Adams gave the report on the determination of Solar Rotation by the displacement of lines, and spoke of the use of the plane grating in measuring Solar rotation at Mount Wilson.

Professor Frost presented the report of the Committee on the spectroheliograph. It was decided that daily photographs of Calcium flocculi should be continued.

In addition to the meetings, the astronomers made a detailed inspection of the instruments used in the advancement of astronomy, particular interest being taken in the new tower telescope, 180-feet high including dome, and its 80-foot deep pit for the new combined spectrograph and spectroheliograph. The tower is surmounted by a dome containing a coelostat and necessary mirrors to project the beam of light on to the 12-inch object glass, situated near the summit of the tower, which focusses the image of the sun on the slit of the spectrograph in the house at the foot, the sensitive parts of the spectrograph being situated in the underground pit to maintain constant temperature.

FIGURE 3.

July 20, 1905, $5^h\ 18^m$. High-Level Calcium Flocculi Slit set on H_2. Sun's Diameter = 0.28 meter.

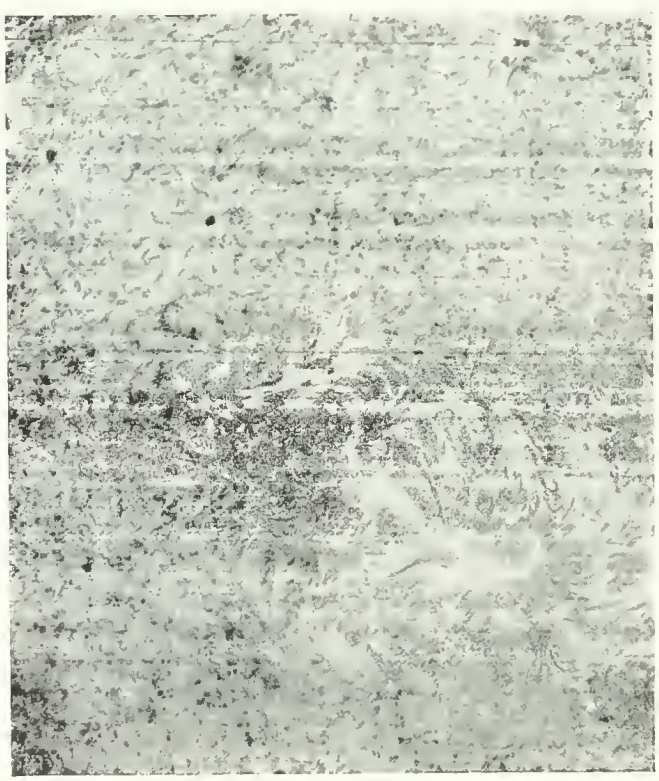


FIGURE 4. Hydrogen (Hα) Flocculi photographed with the Snow Telescope and 5-ft. Spectroheliograph.

The tower itself is really two towers, one within the other, having about 2-inches clearance between them, so that the inner one is shielded by the outer from the direct rays of the Sun, and also from the force of the wind. It is this insulated portion which carries the coelostat and objective.

When the new spectroheliograph is completely installed, there is every reason to expect that Professor Hale will surpass the results he has already obtained.

Figures 2 and 3 show some of the Calcium Flocculi photographed with the Snow Telescope and spectroheliograph.

Further, the new 5-foot reflecting telescope constructed by Professor Ritchey was thrown open for the delegates to make observations. It was estimated that stars down to the 17½ magnitude could be visually observed, which is half a magnitude fainter than hitherto approximately obtained, whilst photographs show stars down to the 21st magnitude.

Saturn formed the subject of much scrutiny, and the definition, using a magnification of 600, was superb. Several important new features on the planet were discovered, whilst other details imperfectly established were confirmed and fully observed.

Other objects of interest were viewed, such as the Cluster in Hercules, and it is the good fortune of few astronomers to observe such objects with a magnifying power of 600, giving crisp definition and an aperture of five feet.

The 5-foot telescope can be arranged for visual work with an equivalent focal length of 100-feet.

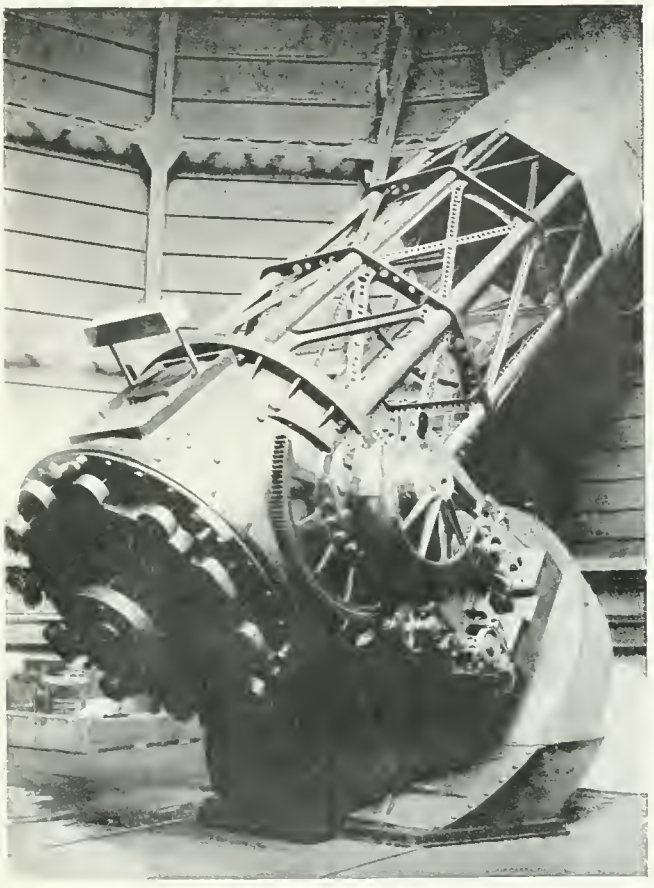


FIGURE 5.
A 5-foot Telescope at Mount Wilson.

On the return journey arrangements had been made for the delegates to visit the various observatories of Lick, University of California at Berkeley, San Francisco, Yerkes, Allegheny, and Washington. Each of these observatories placed their instruments at the disposal of the parties. With such generosity and among such a series of powerful instruments it would be invidious to point to any one in particular, but a striking feature of the observations made with the 40-inch telescope of the Yerkes Observatory was the ease with which one could see the faintest planetary nebula and the two faint stars in the Ring Nebula in Lyra.

One cannot help feeling that the science of astronomy is very much alive in America, and that such meetings not only stimulate the spirit of scientific research, but tend to national goodwill.

NOTE.—In connection with the article printed on Pages 433–5 in "KNOWLEDGE" for last month, Professor Hale, who is now in England, has kindly written the note which is printed below.

THE article on the Mount Wilson Solar Observatory in the November number of "KNOWLEDGE" contains so many errors and obscure statements that it is impossible to correct them all. The account of the Snow telescope is badly confused. The concavity of the third mirror is not "very great," as stated, but very slight, as the radius of curvature is sixty feet. The light of the Sun, or other object under observation, does not "fall through" the two plane mirrors, but is reflected from their silvered front surfaces. Nor do the observers "stand round" the third mirror, but near the focal plane, sixty feet from its face. "Pasadona" should be "Pasadena." "Ellerton" should be "Ellerman," and "Carnegie Institute" should be "Carnegie Institution" (the Carnegie Institute is a combined library and museum in Pittsburgh).

Mr. Adams is second in charge, and serves as Acting Director in the absence of the Director. Other members of the staff, not mentioned in the article, are Professor Kapteyn, Research Associate; Professor Seares, Superintendent of the Computing Division; Dr. King, Superintendent of the Physical Laboratory; Professor Ritchey, observer with the sixty-inch reflector; Dr. St. John, solar observer; Mr. Babcock and Dr. Foth, assistants. Mr. Backus has not been connected with the Observatory for several years.

The description of photographs of the calcium lines (p. 435, top of second column) is hopelessly confused, and the subsequent remark, which seems to imply that "they can take a photograph twice a day" in the physical laboratory, is equally so. The meaning of "twenty-six acres below" (near the foot of the page) is a mystery. The sentence "The buildings are permanent, but others are still to come for the great five-inch reflecting telescope" is difficult to understand. Apparently it refers to the sixty-inch reflecting telescope, which has been in regular use in its dome since December, 1908. Possibly the author's visit to Mount Wilson was made several years ago, as he does not mention the sixty-foot tower telescope, erected in 1907, or the recently completed one hundred and fifty foot tower telescope.

The final sentence of the article is also misleading. The Observatory did receive an appropriation of $150,000 from the Carnegie Institution for expenditure in one year, but less than one-third of this was used for maintenance, the balance being devoted to the purchase, construction and erection of buildings and instruments.

OPINIONS RENDERED BY THE INTERNATIONAL COMMISSION ON ZOÖLOGICAL NOMENCLATURE, JULY, 1910

By THE REV. THOMAS R. R. STEBBING, M.A., F.R.S.

"I WENT by the field of the slothful, and by the vineyard of the man void of understanding; and, lo, it was all grown over with thorns, and nettles had covered the face thereof." So spoke one of old, reputed to be the greatest naturalist of his age, supremely conversant alike with the vegetable and animal kingdoms of nature. Well, here, nearly three thousand years later, we have the field of the industrious and the vineyard of distinguished zoölogists, and, lo, it is all grown over with thorns, and nettles cover the face thereof. What these thorns and nettles are I shall seek to explain, with ready recognition that to a large extent they may be due much more to the soil which has to be cultivated than to any fault of the cultivators.

To begin with, we are at an epoch when the unity that underlies the diversity of natural phenomena is making itself more and more appreciated. Yet botanists and zoölogists have chosen this very period for settling how to name the objects of their respective sciences by separate sets of rules. Though alike accepting the introduction by Linnaeus of the binominal or binomial system as a starting point for the scientific nomenclature of living organisms, they have nevertheless chosen each a different date for that starting point. Eventually the zoölogists, who have already harked back from A.D. 1767 to 1758, will perhaps do themselves the credit of joining the botanists in dating the beginning of the world (of Natural History) from 1751.

In the next place, we have to consider the main purpose of the present International Commission. A brief history of it is given in the pamphlet under review.* Its appointment dates from 1895, at the Third International Zoölogical Congress. The following Congress, the only one that has been held in England, was a brilliant gathering at Cambridge, in 1898. On that opportune occasion all public discussion of the question in hand was deliberately quashed. The commissioners, five in number, were authorised privately to coöpt ten others. No fault can be found with the standard of ability in the men chosen to serve. Rather, in some cases, one might feel that a razor was being used to cut through a whetstone. By the arrangement that at each triennial Congress a group of five members should retire, the term of office for each group becomes normally nine years, sufficient, one would think, to secure continuity without stagnation in the methods and resolves of the Commission. But this salutary rule is at once stultified by a rider permitting the immediate re-election of retiring members. Apart, however, from any faults in its constitution, the purpose of the Commission is on the face of it highly laudable, namely, to secure uniformity among zoölogists all over the world in the technical designation of the objects they study.

How, then, is this purpose being pursued, and with what chances of success? Confessedly, "the Commission has no legislative power," nor, for that matter, has the Congress which appoints it. The work must be done by persuasion and consent. Yet, so far as appears, the numerous societies in Great Britain and Ireland more especially concerned with zoölogy have not been in any way approached for an expression of their wishes or opinions. Any society, or any private individual, may submit to the Commission views or problems, but no judgment upon them can be hoped for unless they have been sent in at least one year prior to the meeting of the next Congress; thus, perhaps, leaving an unhappy enquirer with an interval of three years and eleven months or more between his question and the tortoise-like response. When these dilatory tactics are understood, it is probable that writers will act on their own advice with more satisfactory promptness. If a member of the Commission were himself bringing out a treatise, he would assuredly try to bring it up to date by critical citation of the latest arguments, whether for or against his own point of view. Why should the Commission pursue a different policy? It is evident that they do, for in January, 1903, the *Zoologischer Anzeiger* published a long article by Dr. von Linstow, which in May, 1907, was translated in *the Annals and Magazine of Natural History*, under the heading "Modern Helminthological Nomenclature," while the Commission in its recently published opinions does not condescend to argue with Dr. von Linstow, or to notice him at all. But to ignore is not to conciliate, much less to convince.

Without trespassing on the science of the Helminthologists, which has thus been left in the lurch, I shall venture to challenge certain opinions here rendered in a branch of study with which I am more familiar. Opinion 11 deals with "The Designation of Genotypes by Latreille, 1810." The case is stated by Miss M. J. Rathbun, the eminent

* Published by The Smithsonian Institution, Washington.

American carcinologist, with whom I argued the matter out in *Natural Science*, Vol. XII., No. 74, April, 1898. Now Dr. Stiles remarks, "The Secretary has examined Latreille (1810) in search of evidence in support of the contention which Miss Rathbun states has been advanced, but he has failed to find it." The failure is remarkably like Nelson's failure to see a signal with the telescope applied to his blind eye. Had Dr. Stiles read my article, to which his attention was called by his fellow-commissioner, Dr. Hoyle, he could scarcely have persuaded twelve of his colleagues to concur in an opinion based on an irrelevant failure. Latreille's own writings show that he used the French word "type" as an equivalent of the French word "exemple," and that he could have had no intention by the list in his manual of 1810 to set up what are now understood as typical standards for genera. It may be urged that in this subject matter we have nothing to do with an author's intention, but are only concerned with what he actually published. Those who have followed this controversy will be aware that the authority of Latreille's manual was invoked in order to annex the genus *Astacus* for the freshwater crayfish instead of the marine lobster. My contention has all along been that the genus *Astacus*, at one time very comprehensive, was first subdivided by our countryman, Dr. William Elford Leach, who allotted *Astacus* to the Common Lobster, *Nephrops* to the Norway Lobster, *Potamobius* to the River Crayfish. It seems to me absurd that the lobster should be deprived of its historic name *Astacus*, because of the casual mention of *Astacus fluviatilis* in a text-book, which neither in practice nor design distinguished it generically from the lobster. But, if we are really to be bound by casual mention, the dispute can on those terms be decisively settled, since Borlase, in his "Natural History of Cornwall," p. 274, names "the lobster, or *Astacus verus*," but gives no scientific name to the crayfish, only recording its absence from Cornish rivers. Borlase's work happily was published on the first of January, 1758, the very day on which zoölogists have agreed that their binominal nomenclature was born.

A suggestion, in itself not unattractive, has been made that in the several departments of zoölogy lists of long established and familiar names should be drawn up, to be guaranteed against disturbance without regard to any future claims on the ground of priority. The proposal, however, deserves to be treated with the greatest caution, to judge by a few examples put forward not long ago, apparently as too obvious to need discussion. One of them was this very genus *Astacus*. Could any example be more fatuous: since no one has ever wished to cancel the name itself, whereas about the application of it controversy is still acute? The Commissioners will have no enviable task, if, or when, it falls to their lot to decide between names endeared to particular specialists on the one hand, and on the other that rule of priority which they themselves have hitherto staunchly upheld. The loss of familiar names is, after all, only a passing inconvenience, a trifling matter compared with the mass of new genera and species which the progress of science evolves.

Opinion 20 decides, by a majority of Commissioners, that Gronovius, in 1763, uses mononominal generic names, which are so far valid, although his nomenclature is non-binomial as to species. But why drag in Gronovius? If uninominal generic names are to be valid in 1763, on what principle are they invalidated at any earlier date? When did writers ever make a practice of using two words for the name of a genus? Let us go back at once to Aristotle, concerning whom Latreille writes in 1803, "Il est facile de conclure des observations d'Aristote, que son *astacos* est l'écrevisse de mer ou le homard." Let us say to the carcinologist: Canst thou read Greek? If so, there is no need to trust Latreille. The evidence can be read in Aristotle's "History of Animals," book 4, chapter 2, so plainly given, that a reader must for very shame confess that, just as the Greek philosopher called the lobster *astacos*, so the French naturalist accepted the lobster as representative species of his *Astacus*.

Opinion 17 asks the question: "Shall the Genera of Weber, 1795, be accepted?" To this enquiry my answer in the negative was fully explained in the *Journal of the Linnean Society*, vol. 29, p. 333, April, 1905. Twelve of the Commissioners answer in the affirmative with sundry qualifications. Dr. Hoyle, on the other hand, very pertinently observes, "I do not think Weber creates these genera: he merely states that they are about to be created. It seems to me such a case as would occur if a publisher were to issue a prospectus of a forthcoming work, and in a table of contents mention such a genus as containing such a species." Instead of being guided by Dr. Hoyle's sound common sense, the Commission has encumbered itself with F. Weber's juvenile futility, and tried to impose on Latreille proceedings which he never contemplated.

Opinion 16 introduces, incidentally, a very interesting piece of history. The explanation is given that Linnaeus followed in general the plan of adopting older names unless this resulted in tautonymy. Without knowing that this plan was originated by Linnaeus himself, I have long ago pointed out that it was the usage of his followers, which ought not to be interfered with by an *ex post facto* rule. For example, *Cancer crangon* of Linnaeus was renamed *Crangon vulgaris* by Fabricius, to avoid the tautonomy of *Crangon crangon*. There was probably a practical advantage in old times, when the too comprehensive genera of those days were subdivided, in using well known specific names for the new generic compartments. Some ears may admire the jingle of *Scomber scomber* and the like, but Linnaeus and many of his followers, down at least to the time of Dana, were against it. There is no propriety in our reversing their evidently well considered usage, whatever regulations we may think proper to make for our own guidance in the future. Hoping that the long discussion of Opinion

16 was leading up to this conclusion, at the very end I find, on the contrary, ten Commissioners agreeing that some unfortunate invertebrate ought to be named *Chaos chaos!* I can only hope that at some future revision it may be called *Tohu vabohu*.

One opinion is conspicuous by its absence, and will, it appears, not put in an appearance in the report of the Congress held at Graz last August. It concerns the question of genders in Zoölogy, which was submitted to the Commissioners years ago by a learned Society and recently recalled to their attention by copies of an article from these columns. This question is therefore left to be determined by the usage of authors, and I can only regret that, while modestly waiting for the opinion of the Commissioners, I have neglected favourable opportunities of giving practical effect to my own. To show in a striking light the needless perplexity produced by forcing Latin concords upon natural science, let me offer a few more examples from authorities, most of them of high repute. Latreille is responsible for *Termes capensis* and *Termes fuscum*: Milne-Edwards for *Hippolyte ventricosus*: Kroyer for *Tucca impressus*: Brady for *Pontella securifer*: Giesbrecht for *Labidocera acutum*: but Giesbrecht and Schmeil for *Labidocera acuta*: Ortmann for *Sesarma catenata*: Stebbing for *Sesarma catenatum*. How many naturalists could, without an inordinate amount of trouble, discriminate between the right and the wrong in these genders, or explain the origin of any errors committed?

One there was among the Commissioners who, with more ease than most men, could have accepted this challenge. Dr. von Maehrenthal was present at the recent Congress, but is, alas, no longer among us. As assistant editor of "Das Tierreich" he was Professor F. E. Schulze's invaluable comrade, loyal, indefatigable, self-effacing. His loss may well be called irreparable, unless it may induce the Berlin Academy to take into alliance kindred institutions in other nations for carrying out the gigantic task they have in hand. To give an idea of the distance between us and our chief luminary Sir Robert Ball imagined an infant with an arm capable of putting its fingers on the sun, reckoning that the sensation of any consequent blister would not reach the brain till the child had become an old man. Similarly, in the task of describing all the animals of the world, however we name them, there is a risk that, without a combined effort, the beginning will be long out of date before the end is arrived at.

THE SPECTROHELIOGRAPH.

By FRANK C. DENNETT.

THE most powerful instrument in the hands of the solar physicist is the spectroheliograph. The focal image of the sun, formed by an object-glass of very long focus, is made to fall on the slit plate of a spectroscope, the slit of which is greater in length than the diameter of the image falling upon it. As the object-glass has a long focus, that of the collimating lens must be proportionally long. The diagram (Figure 1) shows the optical contents of the prism box of the Mount Wilson "Rumford" spectroheliograph. C is the tube of the collimator; D was formerly a plane mirror, but is now replaced by a diffraction grating ruled with twenty thousand lines to the inch; P P two light flint glass prisms 60° angle. The spectrum, instead of being examined with a telescope, is caused to fall upon the sensitised plate which replaces the eyepiece of the observing telescope. Before reaching the plate, however, it is intercepted by a second slit, which cuts off all the light save that passing through the tiny portion of the spectrum required—say the K line of Calcium, or the C line of Hydrogen. The image of the sun travels slowly across the first slit, and the photographic plate is caused to travel behind the second slit, by clockwork, at a corresponding rate. Two exposures are made when prominences and disc are to be photographed. A slower exposure for the prominences, the disc being hidden by a screen, and a second rapid exposure, when the screen is removed, for the disc. The total deflection of the ray is 180°, the prisms doing the double work of increasing the dispersion, and getting rid of the small amount of scattered light caused by the diffraction plate. Hydrogen prominences and flocculi are best studied in photographs taken in the red light of C. The greater the density of the gas or vapour causing a line, the greater also is the width of the line. The closer a vapour is to the sun, the greater is its density also. Hence it is found that by taking photographs with the light of the middle of a line and comparing it with that of the edges of the line a different image is obtained. The photograph obtained with the centre of the line is largely that of the upper clouds, whilst that with the edge of the line is a picture of the lower, denser masses. The difference in the case of the C line of Hydrogen is well shown in the plate in "KNOWLEDGE," facing p. 4 of the present volume.

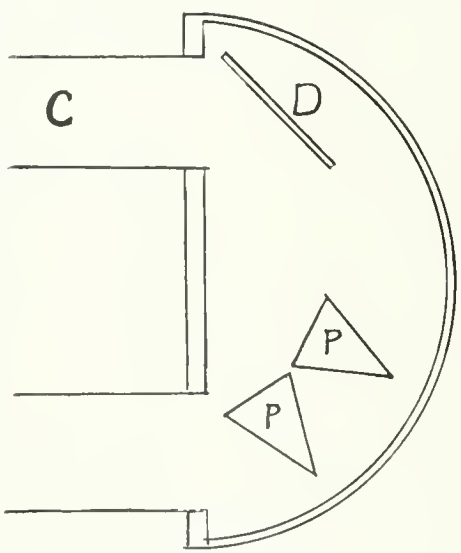
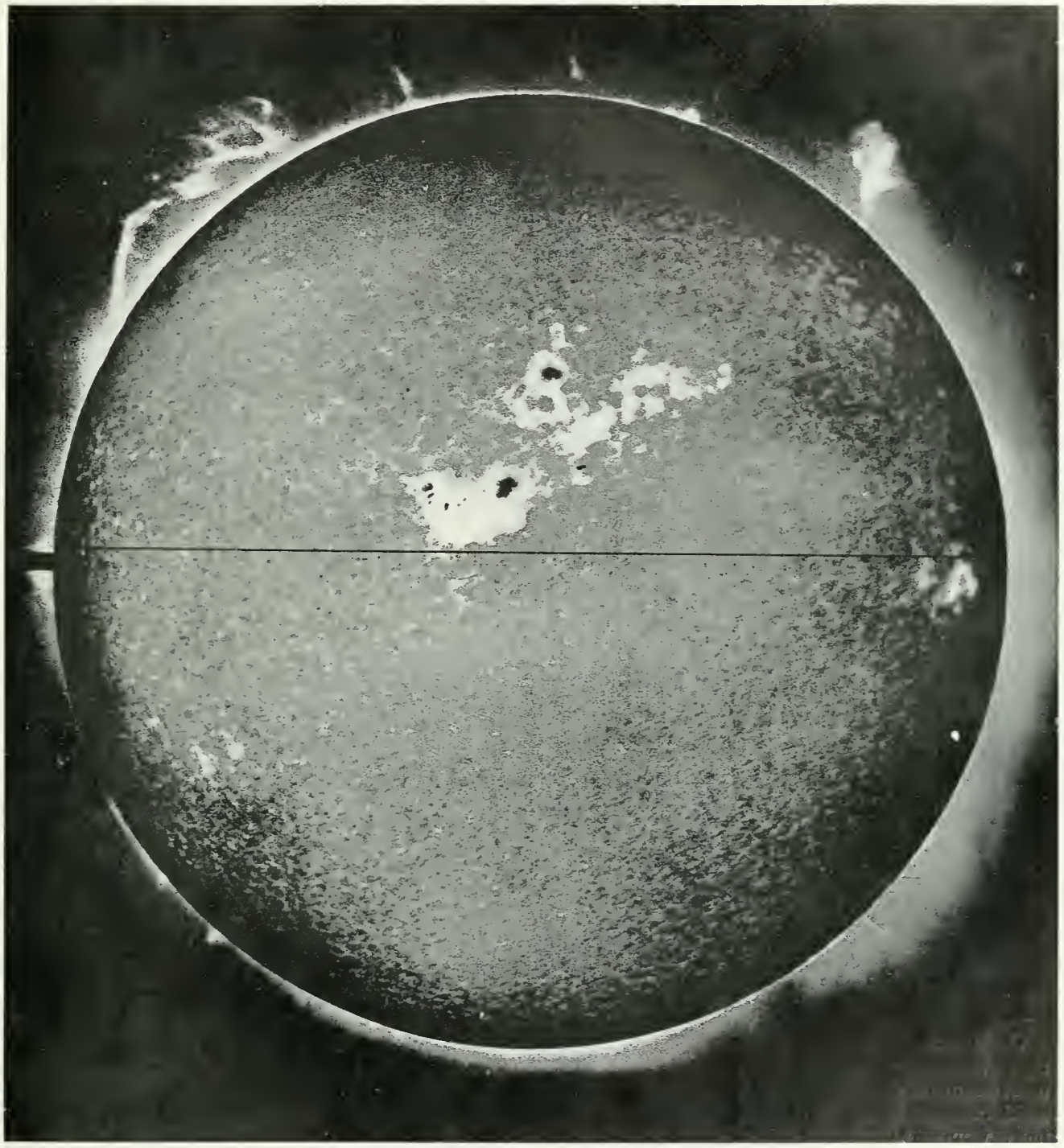


FIGURE 1.

The spectroheliogram now reproduced, kindly sent by Professor George E. Hale, from Mount Wilson, was taken July 17th, 1907, in the light of calcium. The prominences around the southern hemisphere are very fine. The tall tree form on the south-western limb has an altitude of eighty-seven thousand miles. The beautiful double arch south east extends over a distance of two hundred and thirty-four thousand miles, the taller arch being fifty-five thousand miles high, whilst the cloudiness over the southern arch reaches over eighty-two thousand miles in height. The great calcium clouds, or flocculi, over the faculae of the great group near the centre cover an area over one hundred and thirty-seven thousand miles east to west. The less dense mass about north, and preceding the more southern great spot, reaches two hundred and thirteen thousand miles in the same direction. This last group presents one peculiar feature—the chain of almost equi-distant openings extending through nearly its whole length.



A Spectroheliogram of the Sun in Calcium. July 17th, 1907.

By the courtesy of Professor George E. Hale, of Mount Wilson Observatory, California.

TREASURES OF THE SNOW.

By JEAN M. THOMPSON, Author of "Water Wonders."

(Photographs by permission of Wilson A. Bentley).

ON a winter's day, when the big, white, feathery snow flakes come swirling down from the sky, how often we pause to brush them impatiently from our sleeves, never stopping to give them even a casual glance. Now, if by chance a rarely beautiful jewel were to suddenly fall from space and alight upon our sleeve, I doubt if we would brush it aside so rashly. This is, perhaps, just what you have done, however, in brushing aside the snow flake so carelessly; you have destroyed some perfectly exquisite snow jewel.

Not every snow flake which comes to us from cloud land is perfect in design. Mr. Wilson A. Bentley, widely known as the "original snow flake man," has devoted over twenty years of study to frost and snow crystals. During this time he has photographed over two thousand perfect snow crystals. It is an amazing fact that nature never duplicates the snow crystal designs, for he has never discovered two crystals precisely alike.

Now, if we were to make a compact ball of all these two thousand snow crystals, it would only occupy about one cubic inch. Think, then, of the simply uncounted millions of snow jewels which we ruthlessly crush under foot in a short walk.

By some strange law which governs Nature, the rule of six is always carried out in the formation of a snow crystal: they always retain the hexagonal in outline, or the six sides. No matter what intricate design they follow, be they star-shaped, flowers, pin-wheels, duplicates of cuff buttons, or leaf-like, there are always six branches. The crystals start in their growth from a tiny nucleus or central dot or prism of ice, the branches shooting out therefrom, always growing outwards, each section being a perfect design in itself, and all growing simultaneously.

One fancies at first glance that the open, feathery type of crystal, which is also most showy, to be the most beautiful design, but a closer study of the more solid, compact types of crystal, shows them to be more wonderful, and this latter type also grow in much more leisurely fashion than do the open crystals. The large, feathery crystals are grown in low-lying storm clouds, in the big, warm clouds which assemble quickly in low altitudes, and we speak of this type as a "snow flurry." Frequently these showy crystals drop from clouds above which the sun is shining.

The solid crystal is usually a great traveller, frequently coming to us from the distance of eight miles, farther than the most daring aeroplane has yet presumed to venture. Far on high, in this altitude, where the great blizzards are born, the atom of a snow crystal starts forth from a mere dot of ice, which, in a lower, warmer altitude would be a drop of rain. The atom starts to descend, but is again and again caught back into space by up-rushing clouds, and perhaps buffetted about for many days, meeting many ever-changing currents of air, electricity and moisture, putting forth its compact, six-sided prism-like branches as it slowly develops, a mere plaything for the capricious, howling blizzard, until finally the crystal solidifies, becoming thicker and heavier, and then, owing to its increasing weight, it finally descends to earth.

The wonderful designs traced upon the surface of snow crystals are caused by inclusions of air, the crystal itself being formed by tiny, invisible molecules, or particles of water, which float in the air. A close study of these mysterious tracings is well worth while, and well may Job have considered them and called them to our attention as he has in the following:—

> "Hast thou entered into the treasures of the Snow?
> Or hast thou seen the treasures of the hail?"

Study for yourself, the strange markings, the suggestive Egyptian hieroglyphics traced upon a snow crystal: what may they not signify?

The photographing of a snow crystal is wonderfully fascinating, we are told, for one never knows just when he will discover the really prize gem in all this great collection. But to deal with the snow-flakes, one must possess an infinite amount of patience, a steady hand and a quick eye, for the slides require very delicate manipulation, and one must work rapidly, as the crystals are extremely fragile and short-lived, and evaporate very soon when placed upon glass. The most successful micro-photographs of snow crystals may only be had, taken in a temperature of thirty-two degrees F., or twenty-five degrees above zero. Of course the work must be done out of doors, and frequently Mr. Bentley has remained out in the open during an entire blizzard simply to obtain one or two perfect crystals. It is not easy to detect, at a glance, a perfect crystal; frequently the crystals collide in their travels and are shattered; often they are driven together with such force that they merge together.

and reach us as freak crystals. So, during an entire day's patient waiting, sometimes but one or two rare and perfectly formed crystals deign to alight upon the photographer's black receiving board.

The prism crystal, solid type.

Strangely mysterious and wonderful are the snow crystals: each design a perfect art production in itself, etched out in delicate pattern upon the minute surface of an atom. Few of us have ever paused to consider their rare possibilities. Recently, however, they have been successfully photographed, and their beauty of form and design has appealed to decorators, jewellers, designers of porcelain and glass; while their value as unique patterns for silk and fabric workers may readily be understood; while as models in the Arts and Crafts snow crystals are being utilized.

An exquisite jewel-like design.

So, whenever you chance to be abroad during a snow storm, if your coat is of dark wool material, just give more than a passing glance at the tiny snow flake as it gently alights upon your sleeve; perhaps, if you are fortunate and have keen eyesight, you may discover a perfect gem of a snow jewel.

Each branch is in itself a distinct design.

The feathery low altitude crystal.

THE FACE OF THE SKY FOR DECEMBER.

By W. SHACKLETON, F.R.A.S., A.R.C.S.

THE SUN.—On the 1st the Sun rises at 7.44 and sets at 3.53; on the 31st he rises at 8.8 and sets at 3.57. The equation of time on the 25th at noon is only 7 seconds, and for ordinary purposes is negligible. Winter commences on the 22nd, when the sun enters the sign of Capricorn at 5.12 p.m.; this is the shortest day, the Sun rising at 8.6 and setting at 3.51. Sunspots and faculae may usually be observed on the solar disc, though of late Spots have been rather small. The positions of the Sun's axis, centre of the disc, and heliographic longitude of the centre are given below :—

Date.	Axis inclined from N. point.	Centre of Disc N. or S. of Sun's Equator.	Heliographic Longitude of Centre of Disc.
Dec. 2	15 53′ E	0 38′ N	320 43′
,, 7	13 52′ E	0 0′	203 50′
,, 12	11 42′ E	0 38′ S	197 58′
,, 17	9 26′ E	1 17′ S	132 5′
,, 22	7 5′ E	1 54′ S	66 13′
,, 27	4 41′ E	2 31′ S	0 21′
Jan. 1	2 16′ E	3 7′ S	294 30′
,, 6	0 11′ W	3 41′ S	228 30′

THE MOON :—

Date.	Phases.	H. M.
Dec. 1	● New Moon	9 11 p.m.
,, 9	First Quarter	7 5 p.m.
,, 16	Full Moon	11 5 a.m.
,, 23	Last Quarter	10 36 a.m.
,, 31	● New Moon	4 21 p.m.
Jan. 8	First Quarter	6 20 a.m.
Dec. 15	Perigee	3 42 p.m.
,, 28	Apogee	2 18 a.m.

OCCULTATIONS.—The following table gives particulars of the principal occultations visible in this country. The bright double star γ Virginis is occulted shortly after midnight of the 23rd.

Date.	Star's Name	Magnitude.	Disappearance. Mean Time.	Disappearance. Angle from N. point. E.	Reappearance. Mean Time.	Reappearance. Angle from N. point. E.
			p.m.		p.m.	
Dec. 5	ω Sagittarii	4·8	5.17	45°	6.21	280°
,, 13	σ Arietis	5·5	6 50	80°	7.50	212°
,, 16	130 Tauri	4·7	5 6	76°	5.57	262°
,, 18	λ Cancri	5·9	9.3	106°	10.2	205
			a.m.		a.m.	
,, 24	γ Virginis	2·0	0.30	148°	1.23	269°
			p.m.	p.m.		
Jan. 11	ν^1 Tauri	4·2	6.11	79°	7.17	237°
,, 11	ν^2 Tauri	5·4	6.43	62	7.52	255°

THE PLANETS.

MERCURY :—

Date.	Right Ascension.	Declination.
	h. m.	
Dec. 2	17 18	S 25 3′
,, 17	18 57	25 0′
Jan. 1	19 53	20° 36′
,, 16	18 52	S 19° 31′

The planet is an evening star in Sagittarius at the end of the month, but is unfavourably placed for observation. On the 24th he is at greatest Easterly elongation of 19° 54′ from the Sun; on this date the planet sets about 5.25 p.m. On the 10th January he is again in Inferior Conjunction with the Sun.

VENUS :—

Date.	Right Ascension.	Declination.
	h. m.	
Dec. 2	16 37	S 22° 1′
,, 17	17 59	23° 58′
Jan. 1	19 21	23° 11′
,, 16	20 41	S 19° 45′

Venus was in conjunction with the Sun on November 26th, and remains in too close proximity to the Sun to be observed.

MARS :—

Date	Right Ascension.	Declination.
	h m.	
Dec. 2	15 1	S 16° 48
,, 17	15 43	19° 33
Jan. 1	16 27	21° 43′
,, 16	17 12	S 23° 10

Mars is visible for a short time before sunrise, as he rises about 5.40 a.m. throughout the month. The diameter of the disc is only 4″; thus for small telescopes he is not a very suitable object.

JUPITER :—

Date.	Right Ascension.	Declination.
	h. m.	
Dec. 1	14 9	S 11° 52′
,, 21	14 23	13° 4′
Jan. 10	14 35	S 14° 1′

The planet is observable for a short time before sunrise, as he rises about 4.30 a.m. at the beginning of the month, and at 3 a.m. on the 31st. The planet is a conspicuous object in the morning sky looking S.E.

SATURN :—

Date.	Right Ascension.	Declination.
	h. m.	
Dec. 1	1 58	N 9° 11′
,, 21	1 55	8 50′
Jan. 10	1 54	N 9 4′

Saturn is a conspicuous object in the evening sky, being due South at 9.18 p.m. on the 1st, 7.17 p.m. on the 31st, and at proportional times on intermediate dates, that is, about 4 minutes earlier each day. He appears about 32° above the horizon as the brightest star in that portion of the heavens, and may readily be distinguished by his lustreless appearance.

The planet may be seen in detail in quite small telescopes: even telescopes of only 2-in. aperture are sufficient to observe details on the disc as well as the Cassini division in the ring, using a magnification of 100, whilst the ring may be seen with a magnifying power of 50. The dark or crape ring requires at least a 4-in. telescope, but it is seen to better advantage in larger telescopes. The diameter of the ball is 18″, whilst the diameters of the outer major and minor axes of the ring are 45″ and 12″ respectively. The Southern surface of the ring is presented to us at an angle of 16° to our line of vision; thus the ring appears well open. The Moon appears near the planet on the evening of the 12th.

URANUS:—

Date.	Right Ascension.	Declination.
	h. m. s.	
Dec. 1 ..	19 38 41	S 22° 0′ 48″
Jan. 1 ...	19 45 39	S 21° 43′ 46″

Uranus is approaching conjunction with the Sun, which takes place 11th January, and hence is practically unobservable, as he sets about 6 p.m. near the middle of the month.

NEPTUNE:—

Date.	Right Ascension.	Declination.
	h. m. s.	
Dec. 1 ...	7 31 16	N 21° 8′ 15″
Jan. 1 ...	7 28 6	N 21° 15′ 5″

Neptune rises about 5.50 p.m. near the middle of the month, and is due South about 1.50 a.m. The planet is situated in Gemini, about four degrees South-East of the star δ Geminorum, but in small telescopes without setting circles it is difficult to identify from the numerous small stars in the same field of view. He may, however, be detected by his motion if observations are made on several successive nights.

METEORS.—The principal shower of meteors during the month is the Geminids, December 10th to 12th: the radiant is near Castor, in R.A. VII.^{h} 12^m, Dec. +33°. The meteors are short and quick, and difficult to record accurately.

Minima of Algol may be observed on the 15th at 9.52 p.m., and at 6.41 p.m. on the 18th. The period is 2^d 20^h 49^m from which other minima may be calculated.

TELESCOPIC OBJECTS:—

DOUBLE STARS.—1 Pegasi 21^h 17·5^m, N. 19° 20′, mags. 4·5, 8·6; separation 36″·2.

π Andromedæ 0^h 31·5^m, N. 33 11′, mags. 4·0, 8·0; separation 36″·3.

α Piscium 1^h 56·9^m, N. 2° 17′, mags. 3·7, 4·7; separation 3″·6.

ι Trianguli 2^h 6·6^m, N. 29° 50′, mags. 5, 6·4; separation 3″·5.

CLUSTERS.—(H VI. 33, 34.) The Perseus clusters visible to the naked eye and situated about midway between γ Persei and δ Cassiopeiæ. These magnificent clusters are described by Smyth as "affording together one of the most brilliant telescopic objects in the heavens."

(M 34.) A mass of small stars about the 8th magnitude: not very compact. The cluster is just perceptible to the naked eye about 5° North-West of Algol.

SOLAR DISTURBANCES DURING OCTOBER, 1910.

By FRANK C. DENNETT.

THE revival of Solar activity, mentioned last month, was continued during October, yet on the 15th only faculae were visible. The way in which disturbances are drawing near to the equator is a significant indication of the approaching minimum of sun-spots. It further appears that the Northern Hemisphere is nearer the end of its cycle than the Southern. The longitude of the central meridian at noon on October the 1st was 67° 16′.

Nos. 70, 72, and 73 were still on the disc at the beginning of October, and are therefore shown on the present chart.

No. 75.—A group of pores seen on the 7th, which dwindled to a solitary pore during a part of the 10th. On the 11th it had redeveloped into a line of pores 68,000 miles in length, but after the 11th it declined until last seen on the 14th.

No. 75*a*.—A spotlet preceding the last, only recorded on the 11th.

No. 76.—A group of faculae on the 7th had a pore at its south-west edge. This had increased to a triangular group of four pores on the 10th, 3° in length, but not seen again.

No. 77.—A group of three pores forming a bent line on the 17th, but on the 18th there was a triangle of four, not seen after.

No. 77*a*.—A nearly circular group of eight pores on the 17th, but reduced to a single pore when last seen on the 18th.

No. 78.—On the 16th, close within the eastern edge or limb, a bright faculic ridge was seen with a spot in front, having a very black looking umbra. On the 17th the umbra was surrounded by a bright fringe, whilst a little south-east there was a smaller spot. Another spot had appeared close east on the 18th, as well as some pores. A bright uprush of hydrogen was also observed east of the leader at 11.15 a.m. By next day the leader had a diameter of 22,000 miles, and the group, which had a roughly elliptical outline, had a length of 65,000 miles. On the 20th the spot had reached a maximum diameter of 30,000 miles, but a good part of its umbra was obscured by a triangular hazy mass. On the 21st the spot began to show traces of breaking up, yet on the 23rd it appeared to be in a very active state. It seemed as if a mass of the photospheric matter had broken in on the northern side of the spot, and two of its umbrae were brightly fringed. Next day the spot had broken up, whilst the group following it had almost gone. The area was marked by a triangle of larger spots and a few pores from the 25th to the 27th, when last seen. As it was passing round the limb on the 28th a bright metallic prominence was visible.

No. 79.—A group, composed of a spot and pores, 44,000 miles in length, near the site of No. 70, was seen to have come on to the disc on the 17th, but the spot was not seen after the 19th, and all were gone by the 22nd.

No. 79*a*.—On the 23rd a new group, 30,000 miles in length, had developed directly to north of No. 79. Variations in size occurred among the pores, two of which continued visible until the 26th.

No. 79*b*.—A considerable group of pores seen 10° east of the last on the 25th, but decreased to two very close pores on the 26th, one of which continued until the 28th, when it was seen in a faculic disturbance, which enclosed the entire district of the 79, *a*, *b*, and *c* groups.

No. 79*c*.—Two pores, only seen on the 25th a little south of No. 79*a*.

No. 80.—A group of pores first seen, close past the central meridian, on the 18th. There were two pairs on the 19th.

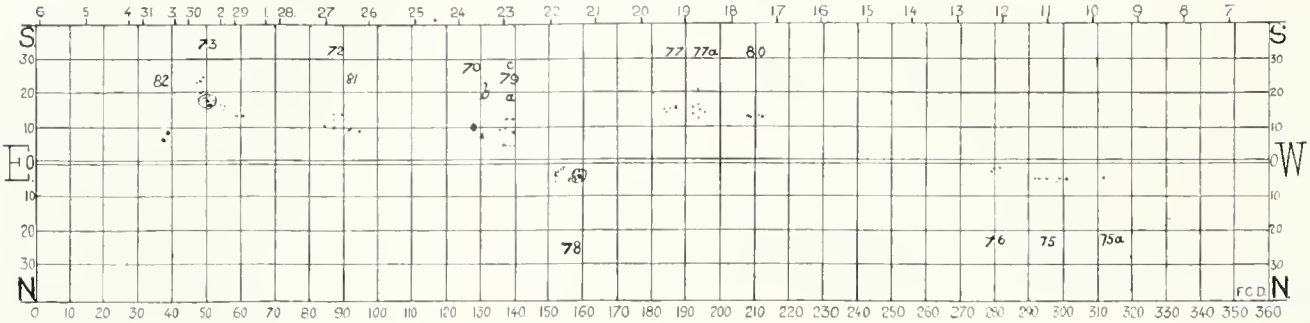
50,000 miles from east to west, but when last seen on the 20th only a solitary pore remained.

No. 81.—A group of spotlets and pores first seen on the 21st, 82,000 miles in length. The numbers and size of its components varied much, but it was last seen on the 28th.

No. 82.—Four pores on the 30th formed a bad square. Next day there were two spotlets, the northern having three umbræ, and the penumbra with its inner edge brightly fringed. The southern spotlet was smaller, but had a companion pore south-east. On November the 1st a spotlet just east of the northern spot, which was gone, however, on the 2nd. All had disappeared before the 4th.

The chart is constructed from the combined observations of Messrs. J. McHarg, A. A. Buss, E. E. Peacock, and the writer.

DAY OF OCTOBER.



CORRESPONDENCE.

POLAR PHENOMENA.

To the Editors of "KNOWLEDGE."

SIRS,—In his work, *The Arctic Home in the Vedas*, Mr. B. G. Filak, of Poona, has attempted to prove that the primitive home of the Indo-Aryan race must be located within the Arctic Circle. He has found numerous references in the early Vedic literature to Arctic phenomena, such as the long day, the long dawn, the months-long night, and so on, which are possible only within the polar regions. Mr. Filak is not alone in this view, but has found a few supporters, even among Western Orientalists, prominent among whom is Dr. Warren, ex-President of Boston University, and author of *Paradise Found, or the Cradle of the Human Race*. If Mr. Filak's theory of the Arctic Home is correct—I, for one, am convinced it is so—there are grounds for believing that the primitive home of the early Vedic people must be located at about $86\frac{1}{2}°$ of polar latitude. Are any of your readers able to tell me for how long a period of time the Arctic sun will be seen, when observed from $86\frac{1}{2}°$ of latitude, to *stand still* at the summer solstice, in the midst of the perpetual sunshine in those regions? The solstice, of course, derives its name from the circumstance of the sun being observed even from outside the Arctic circle, to tarry a little at that point in the heavens. From within the Arctic Circle the period of stay must appear to be still longer. Shall I be correct in estimating such period to last for 10 day-periods of 24 hours each, when the observations are carried out at $86\frac{1}{2}°$? Certain rather obscure references in Vedic literature lead me to deduce that either the period of complete stillness or of exceedingly slow motion at the highest point of the Ecliptic must probably last for either 10 or 21 days. Will any of your readers kindly enlighten me as to the correct length of the period both at $86\frac{1}{2}°$ and 90°?

ANXIOUS.

BOMBAY.

SLOPING IMAGES.

To the Editors of "KNOWLEDGE."

SIRS,—Can any of your readers explain the cause of the curious optical fact that when one looks through a telescope at an upright object, like a flagstaff, keeping the other eye open, the two images are not parallel. If you use the right eye with the glass, the image seen slopes slightly one way as regards the flagstaff itself, and if you use the left eye the image slopes the opposite way. It is evidently a physiological effect, and essential to vision, and is, I suppose, well known to those acquainted with the physiology of vision. Would some one among your readers tell me where I can read the matter up; or, as I have not a British Museum at hand, perhaps they would quote a passage concerning it? Anyone can see this effect if he carefully compares the image seen by either eye through a field glass, using one eye at a time, and the other open. The effect is very marked if with a prism glass you alter the prism till the image seen by, say the right eye, is parallel with the real object, and then look through the glass with the left eye, for you then get the effect doubled, and therefore very apparent.

May I congratulate you on your magazine in its new form, and wish you all success. I sometimes wish you would consider your numerous readers at the ends of the earth, and print your monthly notes a month earlier, for they only reach us when most of the current month is past.

Yours faithfully,

J. B. BLATHWAYT.

CAPE TOWN.

ASTRONOMICAL APPOINTMENTS BY THE GOVERNMENT.

To the Editors of "KNOWLEDGE."

SIRS,—I know that it is perfectly useless to raise any objection to anything the Government or Civil Service Commissioners do. In your number for October I notice two advertisements for assistants in scientific departments, in which the maximum age limit is 25 years. Taking the advertisement for an assistant at the Edinburgh Observatory, what experience can a man of less than twenty-five years of age have of the practical work of an observatory, and what knowledge of historical and current astronomy? If he has been to some University he may be well up in some theoretical astronomy or book work (much of which will never be wanted by him

in an observatory, and he may be twenty-three before he gets his degree), but turns out, after appointment upon book work examination, to be an inefficient assistant. A good practical experience in astronomy is not to be gained in a year or two.

If, on the other hand, one begins observatory work some years before twenty years of age, he will stand no chance in such examinations, having for years given the best of his time and energy to practical work to the greater advantage of the observatory and astronomy. If such an one throws himself thoroughly into the practical work of observations and reductions year after year, becomes an expert practical astronomer, and is encouraged in distinct lines of work—as he may seem specially adapted—or to work in a communistic sense, he will find himself debarred, by the age limit, from having any chance of attaining one of the few astronomical assistantships that are so seldom vacant, and will soon be subjected to the irritation of having to teach a novice and a "senior in position" how to do work in an observatory.

Though I am not writing this useless letter for myself, having gone a very long way past this maximum limit, and well on my way to the three-score and ten limit, I have in my mind several men who have already had 7–20 years thorough experience in practical work and calculations in observatories, have contributed papers to the astronomical world, and have university degrees, who, because they have spent so many years in astronomy, are for ever prevented from rising to higher places as rewards for their past services, by reason of such senseless age limits and curtailment of the powers of directors of observatories in appointing those who they know will best assist the work required to be carried on.

Of course this age limit will continue and novices be appointed, and approved assistants will be discouraged and set aside so long as directors of observatories are apathetic on behalf of young workers. Astronomical appointments made on mere written examinations are like marriages; much better appoint a man who could show ten to twenty years work: one examination or a single piece of work will not make an astronomer.

Those who bear the brunt of astronomical observations in an observatory should be well and better paid, and should be encouraged to improve their knowledge and work by the prospect of rewards to higher positions; because this class of work is very exacting upon the observer's vigour, energy, and health, and he ought not to be discouraged by others of small astronomical experience being appointed over him.

F. A. BELLAMY.

QUERIES AND ANSWERS.

Readers are invited to send in Questions and to answer the Queries which are printed on this page.

QUESTIONS.

Numbers 14, 16, 17, 18 and 20 (page 461) still remain unanswered.

REPLIES.

11. A BOOK ON WASPS.—I can strongly recommend J. G. Sandeman to get Dr. E. L. Ormerod's "British Social Wasps," published about 1868, by Longmans, Green & Co., at 10 6, and probably now out of print, but to be obtained second-hand for a few shillings. It deals with the life-history, anatomy and physiology of our seven British species, gives a short bibliography, and contains illustrations of nests and coloured plates of the species, showing all the sexes. On the whole, I do not think anyone interested in the subject can do better than get a copy of this work, as it is both popular and scientific.

C. NICHOLSON.

[We are indebted to Mr. E. E. Banham for kindly recommending and letting us see a copy of this same book.—EDS.]

13. THE FINDING OF TIME AT NIGHT.—It is to be presumed the stars are shining and that the Observer knows the Pole Star and its Pointers. Stand facing towards the Pole Star and imagine a great clock face about 35° radius figured on the heavens revolving round the Pole Star in a direction opposite to that of an ordinary clock hand. This imaginary clock face has twenty-four hours marked in the usual order round the face in such a way that the Pointers are at XI.

Suppose it to be in the position in which 0 is overhead and XII vertically beneath the Pole Star.

Now picture to yourself the date of end of 1st week in each month blazoned on the sky permanently fixed. Following the direction of the stars motion, January 7th is at XVI o'clock, February 7th at XII, March 7th at XII, and so on all round. The mental picture of these dates must be fixed. It will be seen we get at the four quarters starting from the bottom, March 7th, June 7th, September 7th, December 7th. We have now only to fix the position in the sky of the date of observation and then reckon round the number of hours to the present position of the pointers. This will give the approximate time.

The reason is very simple. The date position in the sky is the approximate position the pointers occupied that day at noon; their present position shews on our imaginary clock face how many hours have elapsed since then.

Of course the process would be facilitated if so simple an instrument be permitted as a card disc with the dates marked. The card would be held with September 7th at top and at such a distance from the eye that the pointers lie just outside the disc while the Pole Star is seen through a central hole. The disc might be 10-in. in diameter and be held 11-in. from the eye.

Hold it with finger and thumb on the date place, keeping September 7th at top and Pole Star in centre, draw it towards your eye till the pointers meet the edge, run your free finger and thumb round to their point and read off distances between your thumbs. If a disc is made the correct dates should be taken from Whitaker's Almanack each month, the Sun Column Sidereal Time at noon, when the hours of Right Ascension or Sidereal Time are completed. It will be easy to see why they must be placed as directed, to give the noon positions of R.A. XI, which is approximately that of the Pointers. The 7th of each month is nearly right, except for January and February.

S. E. PERCIVAL.

P.S.—Since sending my reply to Query 13, "KNOWLEDGE" for November, I learn from Mr. Hollis, see *English Mechanic*, November 18th, p. 362, that the plan I suggested was used many years ago in an instrument called a "Nocturnal," and that it is described in Hatton's *Dictionary of Mathematics*, *1795*. I need hardly say I was quite unaware of this.

13. We can arrive at a very rough idea of the time, under the conditions specified in this question (p. 288), in the following manner, which will necessitate the visibility of moon and stars. To simplify demonstration, suppose the moon is full, then the shadow of a perpendicular object will indicate the direction of the celestial sphere in which the sun is situated, and from a knowledge of the position of the Pole Star, this direction can be expressed in terms of the cardinal points. But for rough calculations we may assume that the sun will be due west at 6 p.m., due north at midnight, and due east at 6 a.m.; intermediate positions being deduced on the basis that the sun describes (apparently) 15 degrees every hour. Thus, having found the position of the sun by the above method, we can ascertain the time. If the moon be not full, a simple calculation depending on the magnitude of its phase will determine the position of the sun. The inadequacy of this method is of course evident, and, furthermore, if we assume that the stipulated approximation connotes any reasonable

accuracy, or that we are debarred from deducing by observation the cardinal points, then the only alternative left, is to adopt the philosophy of a modern doctrine, and . . . . to ask a policeman.

D. FERGUSSON.

13. F.R.A.S. asks how the time may easily be found by the Stars, and states that Boy Scouts are required to know some method before obtaining their Starman's Badge.

The following is the method I taught the Boy Scouts here, six of whom won the Starman's Badge:—

Imagine the Polar Star to be the centre of the dial of a clock (see Figure 1), and a line from it to γ Ursae Maj. to be the hour hand. On March 31st, this imaginary line from the Polar Star to γ is vertical at 12 midnight. Since all the stars rotate around the Polar Star in twenty-four hours, we can at once estimate approximately the time by observing the position of this line. Thus at 6 a.m. it would be horizontal, and at 12 noon, if we could then see it, it would be vertical, the rotation of course taking place in a direction opposite to that of the hands of a clock. As a solar day is about four minutes longer than a sidereal day, we must deduct, for any other date, four minutes per day after March 31st from the calculated time.

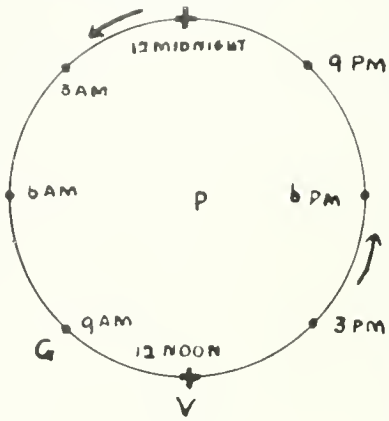


FIGURE 1.

An example will make this clear. Suppose PG represents our imaginary line, P being the Polar Star: on August 8th, the time indicated is evidently about 9 a.m. (PV is vertical). From March 31st to August 8th is one hundred and thirty days. Hence we have to deduct 520 (=4 · 130) minutes, or 8 hours 40 minutes from 9 a.m., which gives the time as 12.20 a.m.

Should Ursa Maj. be obscured by clouds, many other stars will do instead of γ Ursae Maj. Thus, the line we have supposed to be formed by joining the two stars, will pass through β Cassiopeiae. Many other combinations of stars with Polaris will suggest themselves.

(Rev.) M. DAVIDSON, B.Sc.

15. EARTH TIDES.—I should recommend for the study of Earth Tides a perusal of some chapters in "The Tides," by Sir G. Darwin. Then a slight grasp of the meaning of tide-generating force in any mathematical text book of Astronomy, and finally Dr. Hecker's own paper in the *Publications of the Prussian Geodetic Institute*: N.F. No. 32, Berlin, 1907. The latter is in German and rather inaccessible, but in the *Annuaire du Bureau des Longitudes*, 1909, there is an excellent article on the subject. As I see that Mr. Hodgkin is a member of the B.A.A., may I refer him to the Journal, xvii. pp. 181–188 and pp. 233–238, also xix. pp. 304–309. J. A. H.

19. NEPTUNE'S ORBIT AND BODE'S LAW.—I do not think the text-books sufficiently indicate to the student how completely the computed orbits of Le Verrier and Adams differed from the true orbit as later found by observation. So great were the discrepancies that it was soon recognized that it was merely the remarkable coincidence of the celebrated computations having been undertaken precisely at the period when the hypothetical and true orbits happened most nearly to agree (namely during the twenty years or so before and after the 1822 conjunction with Uranus) that had enabled the discovery to be made at all upon the assumed premisses. It was with no disrespect for the marvellous analyses of the two great mathematicians that another eminent mathematician of the time went so far as to call the discovery "a happy accident." The mean distance prescribed by the empirical law of Bode—to which Mr. Dixon particularly refers—was an essential argument in the hypothetical orbits; under observation the so-called law immediately failed, and to an extent computed at the time at no less than seven hundred and thirty-two millions of miles. Present-day figures merely add to the discrepancy another twenty millions of miles. We are not urged, then, by either early or later observations to regard Bode's Law—remarkable as is its application to the distances of the interior planets—as anything more than, perhaps, another "happy accident." Put quite baldly, it never did, and never will, fit any observed position for Neptune.

The remainder of Mr. Dixon's enquiry will be perhaps best answered by a quotation of a few of the early elements found for the new planet, based on observations up to the end of 1853, by which time the planet had only covered in its orbit some 13 degrees of arc. A comparison of these with the presently accepted elements should prove interesting to your enquirer.

ELEMENTS FOR NEPTUNE FOR 1ST JANUARY, 1854.

Mean Distance from Sun (in astronomical units)	30·03627
Maximum ditto	30·29816
Minimum ditto	29·77438
Eccentricity (semi-axis major = 1)	·0087193
Sidereal revolution in days	60126·722
Longitude of perihelion	47° 17′ 58″
Inclination of orbit to ecliptic	1° 46′ 59″·0
Apparent diameter...	2″·4
Diameter in miles	33610
Volume (Earth's = 1)	76·6
Density (Earth's = 1)	0·222

It will be seen from the comparison that, while the physical values have required some revision, the orbital elements found were closely correct.

There will still remain for your enquirer's consideration the very minute perturbations which have helped to the conjecture (to put it no higher) of further external planetary bodies. But something as to this he will have seen in Mr. Chambers' "Astronomical Notes" on p. 447 of your November issue.

W. E. YERWARD-JAMES, B.A.

A ZOÖLOGICAL GATHERING.

ON Saturday, November 12th, a most successful gathering of Zoölogists was held at Trinity Hall, Cambridge. The festivities consisted of a dinner followed by speeches. No less than eighty were present, Sir E. Ray Lankester occupying the chair. The invitation included all *alumni* of Oxford and Cambridge who were engaged in teaching and research in Zoölogy. The president, who was very warmly received, proposed the toast of Zoölogical Science. In the course of his remarks he dwelt on the necessity of bearing in mind that it was the study of form that had dominated, and would continue to dominate, the science to which they were all so much devoted. Morphology, he said, had at least one attribute that should commend it to the authorities of the Ancient Universities, and that was its absolute inutility. There was, perhaps, no other science that was less connected with any form of money-making than Morphology. He congratulated himself that in the whole company present there were hardly a dozen that had not been pupils of his own, or pupils of his pupils. The speeches that followed were equally worthy of the occasion, especially that of the Master of Trinity Hall, who was in his most humorous vein. His remarks were greeted by rounds of laughter and applause. After dinner the company adjourned to the quarters of their hospitable friends, where informal "shop" was talked till the early hours of the morning. On Sunday the zoölogical laboratories were opened to the inspection of the more fortunate whose duties allowed them to spend the week-end in Cambridge. All felt that the gathering had been most successful, and much gratitude was expressed to Professors Bourne and Gardiner, by whom the meeting had first been thought of and organized. M. D. H.

NOTES.

ASTRONOMY.

By G. F. Chambers, F.R.A.S.

THE GERMAN ASTRONOMICAL SOCIETY (continued).—At the second day's sitting of the meeting J. Peters explained the instrument with which the eight-figures Logarithmic Tables, recently published, were formed; in this discussion Bruns, A. Galle, and Boegehold took part.

Grossmann spoke upon the systematic determination of stellar parallaxes, and said that one of the pressing needs in Stellar Astronomy was the determination of a large quantity of parallaxes; he thought that it should be accomplished by the aid of the *Astronomische Gesellschaft*. He considered the method most suitable for this to be by means of right ascension differences, using the Repsold self-registering micrometer; he referred to the advantages and disadvantages of this method and to some results. Ambronn expressed his experience on the Göttingen method of photographic transits; Battermann, Charlier, and F. Cohn joined in the discussion, and a committee was appointed to consider this question and to report to the next meeting in 1912 or 1913; the committee, or commission, consists of Battermann, Charlier, F. Cohn, Grossman, and Schorr.

Charlier gave a resumé of his researches in the domains of mathematical statistics; in the discussion several members took part.

There was a communication from Weiss upon his early conclusion of the new edition of *Argelander's North Zone Catalogue*, which Battermann urged was of great value; and finally an explanation of some pages, by Weiss, of a particular re-formation of Kepler's Equation for the research of the true anomaly in very eccentric orbits by means of Barker's tables.

The third and last sitting was held on Friday, September 16th. After certain preliminaries, Brendel opened a discussion relating to the measures, work, and progress concerning minor planets. The method of special perturbations only serves as a makeshift, and after a considerable discussion a commission consisting of Brendel, Charlier, F. Cohn, Kobold and Witt was appointed to study the questions raised.

Schulz, in communicating a number of graphical exhibitions, gave his views upon the physics of the Sun.

At the afternoon sitting Strömgren gave a general review upon comet cosmogony of the last ten years, specially referring to some of his own work and to that of Fayet and Fabry.

A. Galle then drew attention to the determination of positions in the vicinity of the Poles. There the length of a degree of parallel in 89° latitude amounts to nine furlongs, (1·9^{km}), in 89° 55′ only 177 yards (162^{m}), and at 5″ from the pole it is only 118 inches (3^{m}). It appears impossible to observe the direction of the meridian, or to keep to that direction in a journey from 83° to the pole. Under the most favourable conditions one must at last be satisfied with an error of six miles and one furlong (10^{km}). But at a distance of only 5′ from the pole an error of 30° in the time corresponds to a maximum error of 1″·3 in the altitude; altitude measures in the vicinity of the pole are quite unfit for time determinations; one should direct one's attention to lunar distances.

Battermann moved the general employment of Greenwich time in ephemerides, and was supported by others.

Müller gave a summary of his expedition to Teneriffe in connection with the researches upon Halley's comet.

This concluded the business portion of the meeting. The 15th of September was given up to social enjoyment, by the invitation of His Serene Highness the Prince of Pless, at Freiburg, where an inspection of a watch factory was made, and then over the mountains to Bad Salzbrunn. Fifty-four members attended this biennial meeting, which was very varied and interesting in the topics discussed, and must tend to make those who were present understand better the astronomical problems, and each other.

F.

From a photograph *by Reutlinger.*

Felipe Valle.

FELIPE VALLE, whose death took place on September 1st, at an early age for astronomers, was in 1880 the first assistant Observer and Computer in the Mexican Observatory at Chapultepec. After then he became the professor of physical astronomy and of celestial mechanics at the Engineer's School; the professor of spherical astronomy, of general topography, and of applied mathematics at the Military School; and, at last, the Director of the newly-formed National Observatory at Tacubaya, in 1897. In 1907, Valle had at the Observatory a sub-director (V. Gama), three astronomers, seven assistants, a secretary, and about twelve others.

This Observatory was at first established at Chapultepec, in 1878, and was placed under the direction of Angel Anguiano; in 1883 it was transferred to Tacubaya, at a height of seven thousand and thirty feet, where work in the four distinct branches of astronomy, meteorology, magnetism and seismology is carried on. The contributions to astronomical publications made by Valle were not numerous; they consist mainly of observations upon comets and planets, and are to be found in the *Astronomische Nachrichten*, in volumes 123 to 139 (1889-1895).

Both in Anguiano's time and throughout Valle's directorate a volume of several hundred pages, called the *Annario*, was regularly published; the preparation of the manuscript was

made by the observatory staff; and, though not obvious in the printed books, a considerable amount of time and thought was given to these annuals by Valle. Besides this publication a bulletin was issued occasionally, and reports were made to the Government of Mexico; some of these reports may be found in the *Anuario*.

Since 1892 the main work of the Observatory was the execution of the section of the Photographic Survey.—10° to —16° undertaken by Anguiano and Valle; with this, considerable progress has been made, but no volumes have as yet been published, though about one hundred charts have been printed and distributed. Valle visited England, Europe and the U.S.A. upon several occasions, to attend astronomical conferences in the name of the Mexican nation and science; he had a pleasant, affable and gentlemanly manner, and he was deeply interested in his work. After he had returned from his recent and last visit to Europe his health commenced to decline, and though none of those near him could believe that his end was so near, he died quite suddenly at a little before the middle of the night surrounded by his family.

F. A. BELLAMY, M.A., F.R.A.S.

FIREBALLS IN NOVEMBER.—Every year brings us fireballs in November, and particularly in the first half of the month. These phenomena are indeed very abundant at the close of October, and for several weeks our skies are illuminated again and again by a succession of brilliant meteors. Few of them are fully reported and properly investigated, but from the instances which come to our knowledge we may form some idea of the large number of these autumn fireballs.

They are often seen in the evening hours, and have no connection whatever with the Leonids. Their flights are usually directed from the region of Taurus and Aries, and they move at moderate speed along very extended courses.

This year the Taurid fireball radiant has been strongly in evidence, and has supplied an abundance of fine flashing meteors, equal to Jupiter or Venus, and in several cases they were comparable with the moon's light. To give a list of all the objects observed would occupy too much space, and in many instances the records are imperfect and inaccurate. Recent experience has in fact accentuated the necessity of observers being more precise and careful in their descriptions, and the heavens have lately shown that there is a large amount of work to be done by painstaking observers. In spite of all that has been effected in past years there is still a rich harvest to be reaped in this inexhaustible field.

Observations at Bristol during the early part of November, proved that the following showers were in action:—

33°+18°	163°+57°
57°+15°	192 +70°
58°+ 9	300°+80°
61°+34°	310°+47°

The shower near β Ursae Majoris, is interesting as supplying very swift meteors. It was unusually active on November 5th and 7th. I have seen this radiant point before, at the end of November and early in December, and its apparition at the same point of the sky shews that it is one of the long-enduring radiants.

The Taurids have a double or triple radiant, and require careful reinvestigation. There are certainly well defined points at 63°+23° and 58°+9° with probably a rich radiant between that pair. But it seems a very diffuse shower, and I have found a difficulty in obtaining an exact radiant point for the third shower, though it seems near 57°+15°.

These Taurids furnish many splendid meteors at the period of the celebrated Leonid display.

W. F. DENNING, F.R.A.S.

THE BRITISH ASTRONOMICAL ASSOCIATION.—The Annual General Meeting of this Association was held at Sion College on Wednesday, October 26, Mr. H. P. Hollis in the chair. After the election of Mr. E. B. Knobel as President for the ensuing year, and the new Council and Officers, following on other business, the retiring President gave his annual address. He sketched briefly the progress of the science during the last few years, and drew a striking contrast between the present state of our knowledge and the condition of things forty years ago, dwelling especially on the remarkable development of Spectrum Analysis since the day when the spectroscope was first brought to bear on astronomical objects, and the present condition of things when the spectroscope has come almost into the front rank of astronomical instruments. He pointed out, indeed, that a new name had been invented, "Astro-Physics," for what was almost a new science, based upon two older sciences formerly independent of each other, namely, Astronomy and Chemistry. Mr. Hollis remarked generally that despite what had been accomplished in the way of an increase of our knowledge respecting the Sun, and including the discovery of various new satellites and many minor planets, there yet remained many interesting and important unsolved problems, including the question of an undiscovered planet within the orbit of Mercury, and an undiscovered planet beyond the orbit of Neptune. Mr. Hollis also offered some remarks on the loss to the science of astronomy during the past year of three such distinguished astronomers as Sir W. Huggins, representing England, Galle, Germany, and Schiaparelli, Italy.

TELESCOPES FOR EVERYONE.—Why live, awake or asleep, without a telescope when you can take advantage of this opportunity: "Notice.—The publisher has made an arrangement whereby he can supply readers of this paper with Telescopes at the low price of four pence each, post free." I omit the address and need only say that I have no pecuniary interest in this advertisement, which is from an advertising paper; neither do the words "publisher, readers, and this paper" refer to "KNOWLEDGE." But really amateur and professional astronomers should seize this grand offer of the twentieth century. Galileo, Huygens, Brahè! What would you have given for such opportunities?

F. A. B.

A NEW COMET.—The following telegram from Kiel announces the discovery of a comet in Cancer:—

"Comet discovered by Cerulli, magnitude 10·2.

Nov. $9^d\ 8^h\ 20·8^m$. M. T. Rome.

R.A. app. 54° 38′ 58″

N.P.D. app. 81° 16′ 40″

Daily motion in R.A. − 2′

" " " N.P.D. +19′

No further details are yet to hand.

BOTANY.

By PROFESSOR F. CAVERS, D.Sc., F.L.S.

ALCOHOLIC FERMENTATION.—Some time ago Buchner claimed that the fermentation of grape-sugar (glucose) takes place in two stages—glucose is converted into lactic acid by the ferment zymase, and the lactic acid is transformed into alcohol and carbon dioxide by the ferment lacticidase. Kohl (*Beihefte Bot. Centralbl.*, Bd. 29, 1910) finds that lactic acid is not fermented either by zymase or yeast; that one per cent. or more of lactic acid greatly reduces the fermentative activity of yeast in glucose; but that zymase or yeast ferment sodium lactate rapidly. He therefore concludes that while fermentation occurs in two stages, as shown by Buchner, the latter was mistaken in his view of the enzymes that carry on the processes. Kohl's theory is that catalase transforms glucose into lactic acid, and that zymase carries the splitting on to alcohol and carbon dioxide. In glycerine extract of crushed yeast Kohl found neither an oxidase nor a peroxidase, yet it contained an enzyme capable of oxidising various substances like phenols, and these oxidations he believes are carried on by the catalase present. The extract gave rise to lactic acid, and a trace of oxalic acid, when added to glucose. Kohl's work locates the function of the catalase of yeast, a point not before settled. If zymase is present

the oxidations go no further than lactic acid, which is then changed into alcohol and carbon dioxide. In the absence of zymase the oxidation is carried further, producing various other acids.

PRUSSIC ACID AS PLANT FOOD.—It has been known for some years that certain plants accumulate relatively large quantities of free hydrocyanic acid in their tissues. The late Dr. Treub (*Ann. jard. Bot. Buitenzorg*, 1910) found that the amount of this acid in *Sorghum* plants increases during the day, not owing to the direct action of light, but in proportion to the formation of the products of carbon assimilation. He had already shown, from investigations on *Panginm edule* and *Phaseolus lunatus*, that light has no share in the formation of hydrocyanic acid, except as it favours photosynthesis (carbon assimilation), and much the same results were obtained with *Prunus javanica*. In several other plants also Treub found a direct proportion between the formation of this acid and the function of chlorophyll, and this was confirmed by experiments with variegated leaves. The amount of acid is usually greatest in the young leaves, gradually diminishing as the leaves grow older. With Sorghum, young leaves in a dry season or on dry soil contain so much acid as to be dangerous as food for cattle. Leaves about to fall contain very little acid, as a rule, though Guignard has shown that fallen leaves of Elder contain large amounts of the acid. The prussic acid is probably the first simple organic product of the assimilation of nitrogen; the amount of acid in plants watered with solution of nitrate of soda or potash increased or decreased in proportion to the amount of nitrate used. Treub agrees with Ravenna and Peli's view that nitrates and carbohydrates are necessary to the formation of this acid in plants. In most cases the acid probably does not occur as such, but in the form of a compound (glucoside), from which it can readily be liberated by an enzyme, or by boiling water.

HELIOTROPISM.—Some interesting papers have been published recently upon heliotropism—the curvature movements by which plant organs respond to the stimulus of light.

Guttenberg (*Ber. deutsch. bot. Ges.*, 1910; *Jahrb. für wiss. Bot.*, 1910) has shown that, contrary to the views of most writers, the effect of the geotropic (gravitation) stimulus is not annulled by the light stimulus, but that it is possible to choose light of such intensity that when it strikes from below a seedling shoot placed horizontally, its joint action with gravity will lead to the shoot permanently growing in the horizontal position. Similarly, when a shoot is growing vertically, light of the right intensity will, when directed horizontally on the shoot, cause it to grow at an angle of forty-five degrees. The intensity of light required to compensate gravity, as in these two experiments, varies greatly with different plants; sometimes it is greater than one candle power, but as a rule it is only a fraction of a candle power.

Fröschel (*Anz. Akad. Wiss. Wien.* 1909) re-investigated the "presentation time" for heliotropism, that is, the minimum period for which a seedling grown in darkness requires to be exposed to light in order that, when the plant is darkened again, a distinct curvature may take place. The extraordinary sensitiveness of the heliotropic reaction is shown by the fact that an exposure of 0·0005 second to direct sunlight, or to the light of a mercury lamp, is sufficient to induce curvature in seedlings of Oats. In weak, diffused light an exposure of one-fortieth of a second is necessary.

Haberlandt (*Jahrb. für wiss. Bot.*, 1910) has replied to various critics of his theory of light perception in leaves. It has long been known that in seedlings the tip of the shoot is the sensitive region as regards light. Ordinary leaves place themselves at right angles to the light falling on them, the act of perception being evidently performed by the leaf-blade, while the necessary movement is made by the stalk. If sense organs for light exist they must occur in the blade, and we might expect such organs to lie on the surface. On this reasoning, and on the results of his experiments and anatomical researches, Haberlandt founded his theory that the epidermal cells act as lenses to collect and condense light upon the underlying green cells. To these cells of the epidermis, which have curved dome-like outer walls, he applies the term "ocelli," since they resemble a simple type of eye—a lens and a sensitive protoplasm layer on which the light may be focussed. Haberlandt admits that the epidermis cells on the *lower* side of various leaves are able to condense light, but he points out that the lens-like form of the cells is always more pronounced in the upper epidermis. He points out various weaknesses in the criticisms of Wager and other writers, and it must be admitted that Haberlandt has greatly strengthened his position. The suggestion, made by Wager, that the chloroplasts may serve as organs for light perception is easily disposed of, for the leaves of some variegated plants may be devoid of chlorophyll, yet such leaves respond in the usual manner to light.

Jensen (*Ber. deutsch. bot. Ges.*, 1910) has investigated the conduction of the stimulus of one-sided illumination from the tip of an Oat seedling, where the stimulus is perceived, to the lower portion where (even when this basal part is darkened) the curvature takes place. Rothert had shown that the stimulus is conducted when the veins are cut, and that a horizontal incision on one side—whether towards, away from, or on one flank in reference to the one-sided illumination—still allows conduction. Fitting showed that when the incision was away from the light and a mica plate inserted, no conduction occurred. The insertion of a slice of bamboo in the same position did not prevent conduction; in this case there was, of course, continuity across the incision as regards water, which could pass through the slice of rattan. When the mica plate was inserted in an incision on the lighted side, conduction was not hindered. Jensen states that with the incision away from the light, no conduction ever occurs in dry air or in water. He concludes that under favourable conditions the stimulus can be conducted across the wound, while under unfavourable conditions it cannot. In saturated air the stimulus was conducted from the tip to the (darkened) base of the seedling, even after the tip (nearly half an inch) had been cut off.

It was shown by Berthold, in 1882, that certain seaweeds are positively heliotropic (*i.e.* grow towards the light) in weak light, but negatively heliotropic in stronger light. This discovery was confirmed by Oltmanns (1897) in the case of a mould-fungus (*Phycomyces*), the erect spore-producing threads of which varied in their heliotropic response according to the distance from the source of light—an arc lamp; at 80 centimetres the stalks curved towards the lamp, at 20 to 30 cm. they curved away from it, and at an intermediate distance, of course, they remained erect. Linsbauer and Vonk (*Ber. deutsch. bot. Ges.*, 1909) have recently shown that the same applies to the roots of Radish and Mustard seedlings. As is well known, the radicles of these plants normally show very marked curvature away from the light—hence they are often used in botanical teaching to demonstrate negative heliotropism. It appears, however, that in feeble light the roots of these seedlings show positive heliotropism, curving towards the source of light. It is known that some roots grow towards light under normal conditions, *e.g.*, the roots given out by an onion bulb when grown in water in a "hyacinth glass" placed near a window, but it is probable that these and other cases of differing heliotropic responses in plants will all be found to obey the same general rule—that the nature of the response made by any organ simply depends upon the intensity of the light.

CHLOROPHYLL.—Among various recent observations on chlorophyll, two small but interesting items may be mentioned.

Podiapolsky (*Biol. Zeitschr.*, 1910) has shown that chlorophyll is present in the wings of locusts and in the skin of green frogs; in each case an alcoholic extract gave, on examination with the spectroscope, the characteristic absorption-bands of chlorophyll—in the red region between *B* and *C*. There is no question here of green organisms living in symbiosis with the animal, and apparently the chlorophyll is produced in the animal itself. The writer promises a detailed investigation of the matter, with a view to settling such questions as: How is this chlorophyll produced? Is it concerned in the nutrition

of the animal? Does it remain unaltered when once formed, or does it become used up and reformed?

Stoklasa, Brdlik, and Ernest (*Ber. deutsch. bot. Ges.*, 1909) have carefully re-examined the relationship between chlorophyll and phosphorus in green (chloroplast-containing) leaves. Their analyses, made at intervals from spring to autumn, of Maple leaves, lead them to the conclusion that chlorophyll actually contains phosphorus, contrary to the views of various previous writers.

ANNUAL RINGS IN MONOCOTYLEDONS.—In arboreous (tree-like and shrubby) monocotyledons, there is either no secondary growth in thickness, or a form of secondary growth totally differing from that seen in woody Dicotyledons and Conifers. In various species of *Aloë* and *Yucca*, the new tissues formed by the activity of the growing layer show a definite arrangement in zones or "rings." The structure of these zones has recently been investigated by Lindinger (*Naturw. Wochenschrift, 1909*). In *Yucca filamentosa* and *Y. recurvata* each zone has an inner portion poor in vascular bundles, but rich in ground-tissue (corresponding to the "spring wood"), and an outer portion with the reverse characters (corresponding to "autumn wood"). Just as in the wood of Dicotyledons and Conifers, there is a gradual transition from the earlier to the later portion of each year's growth, but a sharp distinction between the last-formed tissue of one year and the first-formed tissue of the following year. In *Aloë dichotoma* the bundles are evenly scattered, but zoning is produced by the regular alternation of broad layers of soft, large-celled ground-tissue with narrow layers of hard, small-celled tissue.

CHEMISTRY.

By C. AINSWORTH MITCHELL, B.A. (Oxon.), F.I.C.

THE PROPERTIES OF GUARANA.—The natives of Brazil prepare a beverage from the plant known as guarana, the physiological effects of which are very similar to those produced by tea or coffee. An interesting historical outline of the use of the drug is given by Mr. P. H. Marsden in the *Annals Trop. Med. and Parasit.* (1910, iv, 105), in which are included other particulars of its properties. The plant yielding the commercial product is *Paullinia sorbilis*, which grows abundantly in certain districts of Brazil, and also in Venezuela and Guiana.

The seeds of this plant are prepared by being gently heated and pounded in bags to separate the husk from the kernel, and the latter is then crushed to a pulp between stones and mixed with water to form a paste, which is frequently flavoured with cocoa powder, and after being moulded into sticks or cakes is dried in the sun.

It has hitherto been commonly accepted that the active principle of guarana is the alkaloid caffeine, which is present in tea and coffee, and according to the Spanish Pharmacopoeia guarana must not contain less than three per cent of that alkaloid.

The general belief as to the presence of caffeine in guarana has been shown to be erroneous by Mr. Nierènstein, who gives a full description of his experiments in the same journal (*ibid*, p. 115). The alkaloid separated from the drug crystallised in small needles, melting at 217° to 219° C., and after being dried for two hours at 116° C. had a composition corresponding to the formula $C_{10}H_{17}O_{21}N_4$. The amount of tannin separated from the sample was 4·3 per cent, part of which was in combination with the alkaloid. The exact nature of this alkaloid, provisionally termed *guaranine*, needs further investigation, but the results mentioned above prove that it is certainly not caffeine.

ACTION OF ULTRA-VIOLET RAYS ON RUBBER. M. V. Henri, writing in *Caout. et Gutta-percha* (vol. vii, p. 4371) describes the results of his investigation of the effect of ultra-violet rays upon pure and vulcanised indiarubber. Specimens of the pure rubber and samples containing varying proportions of mineral ingredients were exposed, at a distance of about twenty centimetres, to the rays from a mercury vapour lamp with quartz tube. In each experiment there was pronounced deterioration in the pure material within twenty hours, the rubber becoming darker and more shiny, and showing cracks when stretched. In the case of vulcanised rubber greater resistance was offered to the action of the rays, an exposure of forty-eight to seventy-two hours being required to bring about these changes, while rubber impregnated with mineral matter was affected to a less extent, the deterioration being mainly restricted to the surface.

The presence of certain substances, such as antimony sulphide, promoted the decomposition; while other compounds, including litharge, had a retarding influence. Moreover, rubber that had been separated from a solution was attacked more readily than that prepared by evaporation of the latex from the tree.

Since rubber exposed to the lamp in the absence of oxygen was not affected, the change must be attributed to oxidation promoted by the action of the ultra-violet rays. The rays effecting the deterioration were found to be those of a wave-length of about 3,650, which were absorbed by the rubber.

From the results of these experiments the practical conclusion is drawn that the envelope of a balloon ought never to be constructed of unvulcanised rubber, and that the cloth used should be coloured with some pigment, such as lead chromate, which would act as a screen in cutting off the ultra-violet rays, to which a balloon is the more exposed the greater the height it reaches.

DIFFUSION OF PETROLEUM.—There are two main theories as to the origin of petroleum; one regarding it as being produced by the direct chemical union of carbon and hydrogen, while the other attributes the production of the deposits to the decomposition of animal or vegetable remains, with the formation of bituminous bodies, liquid petroleum oils or gases. This latter view is now the one more generally accepted, and the differences between certain oils, such as those of Pennsylvania, which are almost devoid of nitrogenous bodies and sulphur, and those of California, which are rich in those substances, has been explained by the assumption that the former are of vegetable and the latter of animal origin.

Experiments to obtain evidence on this point have recently been made by Messrs. Gilpin and Bransky (*Amer. Chem. Journ.*, 1910, xliv, 251), who show that when crude petroleum of the type found in California, Ohio and Texas is made to diffuse upwards through a porous medium, such as fuller's earth, a fractionation takes place, and a product closely resembling Pennsylvanian oil is obtained. On adding water to the fuller's earth the oil that separates from the top of the tube has a lower specific gravity than that separated from the earth in the lower part of the tube, and there is a gradual tendency to the formation of mixtures that will pass unchanged through the earth. There is also a manifest tendency for the unsaturated hydrocarbon and sulphur compounds to be absorbed, the oil at the top containing a much smaller proportion than the heavier fractions at the bottom. In the light of these experiments it is unnecessary to assume a different origin to the two kinds of oil, since diffusion through porous beds in the earth is quite sufficient to account for the difference between them.

ECONOMIC BIOLOGY.

By WALTER E. COLLINGE, M.Sc., F.L.S., F.E.S.

GRAIN WEEVILS.—A correspondent writes to me with reference to my remarks on *Calandra granaria* last month, and points out how this species, in common with many other weevils, feigns death. Mr. Cole, in his paper, remarks:—"In experimenting with grain weevils, it is important to remember

that no animal shams death so successfully, or keeps it up for a longer time than these small insects. Much of my earlier work had to be repeated owing to my failure to realize this. Afterwards I started a mortuary incubator, kept at the most favourable conditions of temperature and moisture, and only concluded that my specimen was dead after giving it plenty of time to recover in this elysium." In breeding this species I have frequently removed numbers which I took to be dead, but after keeping them for a short time in a temperature of 80° F., quite 90 per cent. have commenced to run about again.

THE ECONOMIC STATUS OF WILD BIRDS.—There has been quite a flood of letters in the press recently, with reference to the vexed question of the economic status of wild birds, and, like previous outbreaks of this character, the main issues have largely been lost sight of. What the majority of farmers and fruit growers, small holders, and so on, contend is that certain birds are practically wholly injurious, *e.g.*, the sparrow, wood pigeon, and bullfinch, and therefore should not be afforded any protection; whilst others, to a large extent beneficial, have unduly increased in numbers of recent years and now constitute a pest, *e.g.*, the rook, starling, blackbird, thrush, and others, and these also should not receive protection for a time.

Whatever town-dwellers, bird-lovers, collectors, and so on think to the contrary, in actual farm practice ample evidence is forthcoming in support of these contentions. Further, *post mortem* examinations of the crops and stomachs show that, although during part of the year some of these birds do destroy a certain number of injurious insects or their larvae, during the greater proportion they feed upon fruit buds, grain and vegetable matter, very much to the farmer's detriment. No one wishes to see our avian fauna ruthlessly destroyed, but to contend that no species are injurious is the best possible way to induce the farmer to indiscriminately kill all he can. A right control is really what is most desirable.

ENEMIES OF RATS.—The recent outbreak of plague in Suffolk once again brings into prominence the question of the extermination of the rat. There can be little doubt but that the increase of these pests is due, to a large extent, to the ruthless destruction of their natural enemies. The kestrel, owl, stoat and weasel annually destroy a considerable number of rats, but, owing to the prejudice that exists with reference to them amongst gamekeepers, they are killed in large numbers. It is very difficult to convince these gentlemen that owls are practically harmless to game, and that the rat does far more harm than kestrels, stoats and weasels. In France and Germany these natural enemies are much more highly valued, and consequently protected, much to the advantage of the agriculturalist and game preserver. The publicity which at present is being given to the damage caused by the rat and the danger it is as a carrier of plague-infected fleas, will no doubt cause the thoughtless to consider whether it would not be better to encourage its natural enemies as the lesser of the two evils.

HOUSE FLIES AND THE PUBLIC HEALTH.—A large number of readers of "KNOWLEDGE" have written me with reference to this most important matter, one that concerns the economic biologist, the medical profession, departments of Public Health, and the public generally. I cannot now deal with the various suggestions and queries beyond stating that I welcome them and fully appreciate their importance, and will endeavour to deal with some of them next month. There is just one point upon which I should like to say a few words, and that is that the statement that flies "as carriers of the germs of such diseases as typhoid fever, tuberculosis, infantile diarrhoea, and so forth, are a potential danger" is not lacking scientific corroboration. There is an abundance of evidence, some of which I will deal with later, to prove this beyond all doubt, and I must confess some surprise that anyone should have doubts about it.

GEOLOGY.

By RUSSELL F. GWINNELL, B.Sc., A.R.C.S., F.G.S.

GEOLOGY FOR THE LAYMAN.—Every November a series of lectures, free to the public, is delivered under the auspices of the British Museum (Natural History) by a graduate in medicine of a Scottish University. These "*Swiney Lectures on Geology*" were this year given by Dr. T. J. Jehu, M.A., F.R.S.E., who dealt with "*The Coasts of Great Britain and Ireland.*" Among the matters dealt with in the twelve lectures were raised beaches and submerged forests, waves and winds, erosion and accretion, sands and sand-dunes, and the fauna and flora of the coast-line. The lectures were well illustrated by lantern slides.

Considerable attention appears to have been devoted to geological subjects in the new (11th) edition of the *Encyclopaedia Britannica*, the publication of which is announced by the University of Cambridge. Including Mineralogy and Petrology the geological articles number nearly one thousand, while the main article, "Geology," contributed by Sir Archibald Geikie, alone runs to fifty thousand words. Mr. H. B. Woodward is responsible for the general arrangement of the articles, and Messrs. F. W. Rudler and L. J. Spencer, and Dr. J. S. Flett, are associated with the mineralogical and petrological branches.

THE MAKING AND READING OF MAPS.—Three lectures delivered under the auspices of the Royal Geographical Society by its map-curator, Mr. E. A. Reeves, F.R.A.S., F.R.G.S., appear in book-form under the title "*Maps and Map-making*" (published by the Royal Geographical Society, 1910). The history and development of surveying instruments is dealt with, followed by a summary of the principles and methods of geographical surveying, and a description of the operations and processes of map-construction.

Almost simultaneously there has appeared "A study in the Geography of the Surrey Hills," by Miss Ellen Smith, under the somewhat clumsy title, "*The Reigate Sheet of the One Inch Ordnance Survey*" (A. and C. Black, 1910). This little book may be regarded as an instalment of the scheme proposed by Dr. H. R. Mill for the regional description of the United Kingdom, and initiated by his own description of the Arundel Sheet. Miss Smith deals first with the geology of this "Surrey highland" district, and afterwards with topography, vegetation, economic resources and industries. The study of communications, place-names and the position of farms and towns completes an interesting volume. A series of folding maps issued with the book includes two on geology. One hopes to see volumes on a similar plan dealing with other areas which are of special interest.

A large relief-map or model of the Ingleborough district, which was recently constructed by Mr. J. F. Stockhouse, F.R.G.S., and published uncoloured, has been taken in hand by the Geological Survey of England and Wales. The outcome is the production of a geologically coloured edition and a descriptive memoir. This memoir, like a previous one on the model of the Isle of Purbeck, is written by Mr. Aubrey Strahan, M.A., F.R.S. Such models, with accompanying memoirs, are likely to be very useful in the teaching of geology in its relation to geography.

JAPANESE GEOLOGY.—Among the "natural resources" of Japan, illustrated at the recent Japan-British Exhibition at Shepherd's Bush, few branches were better dealt with than those of Geology and Mining. The Geologists' Association (of London) visited these collections shortly before the close of the Exhibition.

As a supplement to these exhibits, the Japanese Government publication, "*Mining in Japan, Past and Present*" (1909) is useful. We learn that the history of the exploitation of mineral wealth goes back into the remote past. Pre-historic ornaments of micaceous iron ore and psilomelane may not indicate any knowledge of metallurgical processes, but actual records of the manufacture of swords and metallic mirrors date from 660 B.C. Eight hundred years later, an annual tribute of

gold and silver was levied from the conquered Koreans. The discovery of native copper in Japan in 708 A.D., created such a stir that the era was officially termed Wadō (meaning fine copper), the lucky discoverers themselves (of Korean descent) were appointed Governors of Provinces, and the inhabitants of the region were released from all taxation. At this early period were known such minerals as sulphur, alum, mica and rock crystal, besides azurite, magnetite and other ores.

Leaving the more modern development of the Japanese mining industry to be gathered from the book itself, reference may be made to another paper dealing with Korean geology. Professor Kotô writes in the Journal of the College of Science, Imperial University of Tokyo (May, 1910), on the "*Geology and Ore Deposits of the Hol-gol Gold Mine.*" A granite is intruded into various sediments among which is a limestone, contact-metamorphosed into a lime-silicate-hornfels. Impregnating this hornfels occur various copper sulphide minerals and ilvaite (silicate of iron). The hornfels constitutes the main ore-body (a poor ore-deposit also occurs within the granite itself, developed either by descending waters of a metallic solution or by decomposition of original pyrite). The gold of the main ore-body seems to be closely associated with the copper sulphides, but not with the ilvaite, which latter is shewn by microscopic examination to have crystallised out at an early stage. Professor Kotô regards the ore-deposit as due to contact-metamorphism. The gold was not present at the time of formation of the ilvaite; it is "juvenile" and must have come from deep in the interior as an exudation from the eutectic mixture of the granite magma in association with mineralisers which at first acted as an acid on the limestone and then afterwards metamorphosed it into lime-silicate-hornfels.

METEOROLOGY.

By JOHN A. CURTIS, F.R.MET.SOC.

THE weather of the week ended October 15th was better in the Northern districts than in the Southern, where heavy rains were experienced towards the end of the period. Temperature was in excess of the average very generally; rainfall was in excess in the Midlands and Southern parts, but was in defect elsewhere; while sunshine was in excess in Scotland, England, N.W., and Ireland, N., and below the average in other districts. The maximum temperature reported varied from 70° on the English Channel to 60° in Scotland and Ireland, while the minima ranged from 29° in Scotland to 42° in Southern England. In London the lowest reading in the screen was 44°, and on the grass 41°. Night frosts were not severe as a rule. The lowest reported was 25° at Crathes, with 26° at Balmoral, but at only ten stations did the exposed thermometer register 30° or less. The mean temperature of the sea water varied from 59° to 51°. Sunshine was most in Scotland, N. (42%), and least in England, S.E. (10%). In the latter district the total duration, eight hours, was the lowest amount ever recorded there in a corresponding period.

The week ended October 22nd opened with fair weather in the North and East, but became unsettled in all districts. Thunderstorms occurred on the 17th, and heavy rains in the middle of the week. Aurora was observed in Scotland on the night of the 18th. Temperature was high generally; rainfall was in excess except in Scotland N. and W. and in Ireland; while sunshine was nearly everywhere deficient.

The highest maximum reported was 63° at York, on the 16th, and all districts except Scotland N. had temperatures of 60° or upwards. The lowest minimum was 30° at Nairn and at Balmoral. In Guernsey the minimum did not fall below 45°. The minimum on the grass was 25° at West Linton, near Edinburgh. Rainfall was less than half the average in Scotland N., but was more than double the average in Scotland E. The sunniest stations were in the extreme W. (Valencia, 26·5 hours), and E. (Felixstowe, 26·1 hours), while Glasgow had only 3·8 hours or 5% of the possible duration. The mean temperature of the sea water ranged from 50·0 to 57·7.

The weather of the week ended October 29th was mostly dull but was fairly dry in all but the S.W. districts, where rain was frequent.

Temperature was above the average everywhere; rainfall was less than usual except in the English Channel; and sunshine was deficient in all districts, and very much so in some. The maximum temperatures recorded ranged from 67° in the English Channel to 55° in Scotland E., while the minimum was as low as 32° at Nairn, in Scotland E., but in Ireland the lowest reading did not fall below 43°. The minima on the grass were not specially low for October, the lowest being 27° at West Linton. Rainfall was extraordinarily light in Scotland N. and W., and in Ireland N. Several stations in Scotland W. were rainless this week. In spite of the low rainfall the period was very dull, and at Birmingham and Newcastle no bright sunshine was recorded during the week. At Cambridge the total duration was only 1·4 hours, as compared with an average of 21·4 hours. The highest aggregates were 24·1 hours (34%) at Ramsgate, and 24·0 hours at Plymouth. The temperature of the sea water varied from 46° to 56°.

The week ended November 5th was generally rough and squally with a good deal of rain and low temperature, but with abundant sunshine. Thunderstorms were reported at many stations on November 1st, and an earthquake was felt at Scilly on October 30th. Although the average temperature was everywhere low, maxima up to 60° were recorded at Tottenham. At Greenwich the maximum was only 55°. Readings below freezing point were reported in each district except the English Channel, where the minimum was 41°. The lowest temperature for the week, 23° on November 5th, occurred at Marlborough. The minimum on the grass fell to 17° at West Linton and at Llangammarch Wells. Rainfall was in excess in all districts except Scotland E. and England N.E., but sunshine was also in excess almost everywhere. The largest aggregate of sunshine was 31·4 hours (46%) at Falmouth, and the smallest 6·5 hours (10%) at Westminster. The mean temperature of the sea varied from 56°·2 at Plymouth to 46°·3 at Ballintrae, in Scotland W.

The week ended November 12th was very rough and unsettled, with frequent rains. Snow and sleet were reported in Scotland and the North of England. Thunderstorms occurred at several stations. Temperature was much below the average in all districts. In Scotland E. the highest reading reported was only 46°, but in all other districts maxima of 51° or upwards were recorded. The lowest minimum was 17° at West Linton on the 10th. At Newton Rigg on the same day the minimum was 20°. At Jersey, however, the extremes were 58° and 35°. Rainfall was in excess in all districts except England, S.E.; in some districts the excess was 30% or more. Sunshine was in excess in all parts except Scotland, W., where it was normal. The largest aggregate reported was 34·6 (54%) at Ramsgate, the lowest being 5·9 hours (9%) at Prestwich, near Manchester. The mean temperature of the sea water varied from 56°·2 at Plymouth to 40°·9 at Pennan Bay, on the east coast of Scotland.

A "ballon-sonde," sent up at Pyrton Hill on October 6th, was found at Basingstoke. The Meteorograph record showed that a height of 17km., or 10½ miles, had been attained, with a temperature of 206° on the absolute scale, or −67°C.

COST OF SNOWFALL.—The accounts for the City of Manchester, for 1909–10, show that the cost of the removal of snow in that city during the year amounted to £5,941.

TEMPERATURE OF LONDON IN OCTOBER.—The temperature in Camden Square, London, in October 1910, was 53°·8, or 3°·8 above the average of fifty years. This temperature has been exceeded in four previous Octobers. The month was, however, specially noteworthy for its high minima, the lowest readings of the month, both in the screen and on the grass, being higher than in any previous October since the records were commenced.

MICROSCOPY.

By A. W. SHEPPARD, F.R.M.S.,

with the assistance of the following microscopists:—

ARTHUR C. BANFIELD. ARTHUR EARLAND, F.R.M.S.
JAMES BURTON. RICHARD T. LEWIS, F.R.M.S.
THE REV. E. W. BOWELL, M.A. CHAS. F. ROUSSELET, F.R.M.S.
CHARLES H. CAFFYN. D. J. SCOURFIELD, F.Z.S., F.R.M.S.
C. D. SOAR, F.R.M.S.

RED WATER-BLOOM (*Lamprocystis rosco-persicina* Schroeter).—Owing to the kindness of a fellow member of the Quekett Microscopical Club, I have received some specimens of an interesting organism which he collected from a pond at Hendon. It was chiefly found attached to water-plants along the margin, but some examples were free. To the naked eye it appeared as small irregular sphaeroidal masses of a fine purple or rose-pink colour. Under the microscope these were seen to consist of balls and lobes of very various shapes and sizes, which were frequently joined together in a net-like manner. They were hollow and were formed by a thin membranous layer of extremely minute round bodies, which

FIGURE 1. Red Water Bloom.

often contained opaque granules. The larger compound bodies were sometimes as much as 1-mm. in length and breadth, while the component round jelly-like dots measured from 2 to 3 μ. The organism was identified as one of the sulphur bacteria, not very uncommon, though probably not often recognized, and the cause of red water-bloom. Like many of its relatives, it has been described under various names by different observers. There are at least eight synonyms for it. Sir Ray Lankester, many years ago, found it in some jars containing putrescent remains of animals and plants, which had been undisturbed for a time in his laboratory. He named it *Bacterium rubescens*, and particularly noted its brilliant colour. (See *Quart. Journ. Micr. Sci.*, 1873, N.S. Vol. xiii.). Dr. Cooke, in "Brit. F. W. Algae," refers, there is little doubt, to the same organism, as *Pleurococcus rosco-persicinus* (Rabh.) with the remark that it is "certainly not a good Pleurococcus." It is the *Protococcus rosco-persicinus* of Kützing, and *Clathrocystis rosco-persicina* (Cohn). There is considerable reason for classing it with *Clathrocystis*, as a reticulate form is very common in some stages of growth, but there is no doubt it does not belong to the algae. It is *Beggiatoa rosco-persicina* (Zopf.), and under this name is recorded as occurring in extraordinary abundance in a farm pond at Hampstead. The water was deeply coloured, and weeds and debris entirely covered by it. (See *Science Gossip*, N.S. Vol. vii, No. 83, Apl. 1901.) But Grove, in his "Synopsis of the Bacteria," calls it *Cohnia rosco-persicina* in honour of Professor Dr. F. Cohn, of Breslau, and gives an excellent description, from which the following is taken. Cells roundish, in a simple peripheral layer, forming hollow, round or afterwards irregular, bladders or vesicles, which finally are reticulately pierced. Multiplication of the cells by repeated bipartition: of the families by the separation of daughter colonies. Varying from rose to purple-red. The cells form at first solid families; later the families become larger, globular or ovoid, and finally irregular bodies which are hollow (Figure 1, A). These are often torn or perforated; in the end they present an elegant network (Figure 1, B), which at last breaks up into rags and tatters. The species is distinguished by its red colouring matter, which is designated "bacterio-purpurin" and is insoluble in water and cold alcohol. Each individual cell (Figure 1, C), is surrounded by a dense almost cartilaginous membrane; its contents are at first homogeneous, but as it grows older one or more dark granules can be observed in it, which are found to be nothing but pure sulphur. *The figures are from my own specimens, but somewhat diagrammatic.*

J.B.

CANNIBALISTIC TENDENCIES IN ROTIFERS.—The food of Rotifers consists mostly of small flagellate infusoria, algae, desmids, diatoms, spores of fungi and even bacteria. Some species have learned to pierce the cells of filamentous and larger aquatic algae in order to extract the protoplasm they contain. Another section of Rotifera is essentially carnivorous, and these attack dead or living creatures, such as vorticella, whilst others (such as *Asplanchna*) feed on living Rotifera, which they swallow whole. Each species has jaws, contained in a mastax, suitable for its special food and mode of life, for either crushing, tearing, piercing, holding or sucking, and frequently several of these functions are combined in one mastax.

Though the food of Rotifera is so varied it is rare that one meets with a species which has a preference for its own nearest relations. Such an one, however, is *Plocsoma hudsoni*, a species found in some abundance at a recent Quekett Club Excursion to the East London Waterworks, at Tottenham. The species was first discovered by Dr. Imhof about 1888, in Switzerland, and shortly afterwards appeared in several

FIGURE 2. Cannibalistic Rotifers.

places in Germany and Galicia. Some 16 years ago Mr. John Hood found it in the reservoirs of the Dundee Water Supply, and used to send me specimens from time to time, but with the invariable result that only very few individuals survived the journey, whilst the dead remains of the others could be seen at the bottom of the little bottle. On my informing Mr. Hood of this he called the Rotifer "a most atrocious cannibal," for he had already observed how it attacked and devoured its own kin.

Of all Rotifera this is the most vigorous swimmer; it rushes through the water at great speed, snapping at any other Rotifer that comes in its way, carrying it in its mouth and devouring it without a moment's pause. It is not at all particular as to whether its victim is a *Synchaeta* or its own sister or cousin.

The integument of this *Plocsoma* is tough and leathery; it has a broad somewhat flattened head, and a long stout foot issuing from near the middle of the ventral side of the body. The attacking individual snaps at and holds on to its victim like a bull-dog, and proceeds to pierce the skin by means of that part of the mastax called "incus," after which the muscular

mastax sets up a pumping action which sucks up the soft parts of the victim.

The accompanying illustration shows such a scene and double tragedy, which I witnessed, but which I stopped by killing and mounting all the *dramatis personae* in the middle of the performance. The anterior individual is being carried in the jaws of its captor, whilst the latter has been caught a moment later by a third *Ploesoma*, intent on devouring both. On looking at this picture one can almost imagine hearing the first victim's desperate call of "Help, Murder!" and a moment afterwards the second's yell: "Oh! let go, you villain."

Another, but more unlikely, interpretation of the situation is the suggestion that the third Ploesoma may be a friend of the first victim, who having witnessed the attack, has come to render assistance in the most effective manner.

However this may be, the great tragedy in real life appears almost comical to the observer, and I record it here for the information of those interested in Pond Life. My thanks are due to Mr. A. C. Banfield, who has been good enough to photograph my slide for the benefit of the readers of "KNOWLEDGE."

CHARLES F. ROUSSELET, F.R.M.S.

CRYSTALLIZATION OF SILVER.—Of the many interesting examples of crystallization which may be seen under the microscope there is perhaps nothing more fascinating than to watch the growth of crystals of metallic silver as they spread gradually over the field in beautiful fern-like forms, reflecting the light with great brilliancy as it falls upon them from a bull's-eye condenser or a side reflector. These may easily be produced by dissolving some crystals of silver nitrate in distilled water, and putting a little of the solution into a clean copper ring cell, when the growth will at once start from the sides of the cell and gradually extend towards the centre until its entire area is covered. If a glass cell is used, a similar growth may be seen by dropping into the solution a piece of clean copper wire, on which the crystals will at once commence to form. It is not possible to preserve the beauty of the contents of the cells for any length of time, as the new compound formed by the union of the acid with the copper soon clouds the liquid, finally depositing minute crystals of copper nitrate upon the silver and in this way effectually spoiling its lustre. A better way of showing the formation of crystals of silver is by using a rather deeper cell made of gutta-percha, ebonite, or other non-conductor of electricity, through the opposite sides of which two fine platinum wires have been passed so that one end of each projects slightly into the cell. The other ends of these wires should then be connected with a battery provided with a means of breaking or reversing the current at will. If now the current be switched on, the growth of metallic silver crystals will be seen to start from the platinum wires and will continue until those from the opposite sides come into contact. If during the process the circuit is broken the growth will instantly cease, whilst if the current is reversed the crystals will disappear in the inverse order of their formation, and the curious effect of ferns *ungrowing* will be seen. As soon as the last crystal has disappeared a new growth will start, but this time the distinctive forms will be developed from the wires opposite to those whence they formerly proceeded.

R. T. LEWIS.

MASSILINA SECANS.—In the August number of "KNOWLEDGE" an article by Messrs. Heron-Allen and Earland on *Massilina secans*, invited information as to the prevalence of this species on the East Coast. A holiday at Cromer afforded some opportunity for investigation, and a series of shore-gatherings demonstrated the existence of this form. It may be mentioned that the beach in this district consists of immense stretches of fine sand. Towards the west there appears to be a considerable extent of low-lying rock, the nearer fringe of which is just uncovered at low water.

Gatherings from the eastward or more open beach produced specimens. They occur somewhat sparsely, and in no case was there any indication of the vast accumulations existing off the Irish coast and the southern coast of England. Those, however, which were taken are remarkably true to type, porcellanous in texture, with chambers well-marked and symmetrical. An examination of some hundreds revealed little variation in the relative proportions of the chambers, in the shape, or in tint. Compared with those taken from the Irish coast, the specimens gathered from the open beach were, generally speaking, flatter, the chambers being more oval in section, and there was a conspicuous absence of abnormal or eccentric forms.

The accessible rock-pools, which are very inconsiderable in extent in this district, afforded far more specimens, and these differ considerably from what may be regarded as the type. There is a want of symmetry in the chambers; in some cases both the outer chambers are of abnormal size, in other cases one only has been developed in this manner. The walls are marked with exterior folds, with striae, and with outgrowths of irregular shape, which apparently indicate successful attempts to repair fracture or damage.

The chambers are, in many instances, more circular in section and coarser in texture than in the case of those gathered from the open. Nor is the colour uniform, the dull white of the type being marked with blotches of pink, of brown and of greenish yellow, and in one or two cases the specimens assume an almost vitreous appearance.

These variations, which seem to indicate a highly-developed faculty on the part of the organism to adapt itself to circumstances, are probably due to the altered conditions of existence in the comparatively restricted area of the rock-pools.

In any case, the conclusions of the authors of the article referred to, that *Massilina secans* is an organism of abundant vitality, well able to accommodate itself to its surroundings, and that the different varieties described by earlier authorities on the subject may be more correctly described as accidental variations from the type, appear to be well founded.

FRED LEWIS.

ROYAL MICROSCOPICAL SOCIETY, October 19th, 1910. Mr. E. J. Spitta, L.R.C.P., Vice-President, in the chair. A paper by Mr. Jas. J. Simpson, M.A., B.Sc., on "*Hicksonella*, a new Gorgonellid Genus," was read. The genus is established to include three species collected off South Africa. One species was described by Prof. Hickson, in 1904, under the name of *Juncella spiralis*, but the author showed that a reference to the genus Juncella was impossible. The clearing up of the position of this puzzling specimen was facilitated by recent work of the author in his revision of the family of the Juncellids. In addition to *Hicksonella spiralis*, he described *Hicksonella flagellata* sp. nov., and *Hicksonella capensis* sp. nov. Mr. E. Heron-Allen read a note, prepared by himself and Mr. A. Earland, "On some Varietal Forms of *Massilina secans*." After referring to several varietal forms that had been previously described, the authors related the finding of numerous specimens of three of these varieties in observation tanks where some gatherings of Foraminifera made off Selsey Bill had been placed, and where they multiplied. The conclusion arrived at was that these variations were caused by the want of sufficient shell-making material, the calcium carbonate in the tanks having been used up, the sea-water never having been renewed. A note by Mr. E. M. Nelson on "A Micrometric Difficulty," was read. The author referred to the difficulty of counting correctly the number of ruled lines or diatomic striae in a given space. The trouble does not arise when the interspaces are relatively wide compared with the breadth of the lines, but it does so when the breadth of the interspaces approaches that of the lines. It is the black and white dot image that is responsible for the trouble. When the focus is at a white-dot image, the white lines must be counted, and *vice versa* when the focus gives a black-dot image. Another paper by the same author was also read, "On the Resolution of New Detail in a *Coscinodiscus asteromphalus*." This had reference to the resolution of further detail obtained by a new $\frac{1}{8}''$ objective by Zeiss, described in a previous communication. The new detail

discovered is a fine sieve covering the so-called eye-spot in *Coscinodiscus asteromphalus*. As the size of the eye-spot is only $\frac{1}{1000}$ of an inch, it may be left to the imagination to estimate the size of the minute perforations forming the sieve. There was an exhibition of Pond-life by Fellows of the Society, assisted by Members of the Quekett Microscopical Club.

QUEKETT MICROSCOPICAL CLUB.—October 25th, 1910, Prof. E. A. Minchin, M.A., F.Z.S., President, in the chair. A paper on "Some new African species of *Volvox*" by Prof. G. S. West, M.A., D.Sc., F.L.S., was communicated by Mr. C. F. Rousselet. The first part of the paper referred to the two European species *V. globator* and *V. aureus*, both very well known and with clearly established specific characters. A synopsis of the distinctive characters of these two species was given. Reference was made to the doubtful third European species *V. tertius*, A. Meyer, 1896, and to the description by J. H. Powers of several new American forms, 1905-1906. The two new species now recorded are *Volvox roussceleti* from Rhodesia, and *V. africanus* from the Albert Nyanza.

Mr. A. Earland communicated a paper by Mr. H. Sidebottom on "Two new species of *Cassidulina*." These were *Cassidulina elegans* and *C. decorata*, both obtained by H.M.S. Waterwitch at station 159 S.W. Pacific, depth 1050 fathoms. The second form was also found at station 256, 505 fathoms.

Mr. C. D. Soar, F.R.M.S., read "A Contribution to the list of Hydrachnidae found in the East African Lakes." The material examined was from the Victoria Nyanza, L. Tanganyika and L. Nyassa. The Victoria Nyanza tube yielded only one species (*Unionicula figuralis*, Koch.) which it was possible to identify. From Lake Tanganyika six species were noted, of which three are new to science. These are *Neumania papillosa*, *Midcopsis minuta* and *Hygrobates edentipalpis*. Tube No. 3, from L. Nyassa, yielded but one species, but this was also new, and is named *Unionicula cunningtoni*; it is very close to *U. figuralis*, Koch, but among other differences has a long split seta exactly behind the eyes. The author knew of no other mite having this distinguishing characteristic.

All the new species brought forward were exhibited at this meeting, and are fully described and figured in the November issue of the *Journal of the Quekett Microscopical Club*.

Mr. A. C. Banfield exhibited living specimens of *Cristatella mucedo*, abnormally hatched out from statoblasts about four months before the usual time.

PHOTOMICROGRAPHY.—We have received from Messrs. Wratten & Wainwright, Ltd., Croydon, a small booklet under the above title, which deals in a simple and clear manner with some of the practical difficulties found by beginners. As the object of taking photomicrographs is to exhibit as clearly as possible the structure of the specimen, the question of contrast is all important. Here the advantages of the use of a suitable screen becomes apparent, and on page 9 a table is given showing which screen is most suitable for use with the ordinary staining media. The booklet, which is well got up, is illustrated with reproductions of several photomicrographs.

PREMATURE HATCHING OF CRISTATELLA MUCEDO.—During the last week of September I received, through the kindness of Mr. Rousselet, a considerable number of statoblasts of *C. mucedo*. Except in their most unusual cleanliness there was nothing remarkable in their appearance, and I placed them in a tank to await development.

I have on many occasions hatched out and bred these beautiful Polyzoa, this act always taking place at the end of February and early in March. On October 3rd I was hunting other organisms in the same tank, and to my astonishment saw that four of the statoblasts had hatched out, and the tiny zoöids were particularly healthy and vigorous. It seems to me remarkable that these four individuals should have hatched out prematurely by no less than five months, and, what is perhaps still more curious, that only four out of the large number I received did hatch out.

FIGURE 3. A Colony of *Cristatella mucedo*, three days old.

I can offer no explanation: it cannot be the effect of temperature or more would have hatched. The tank temperature was 58°F., and the tap water at the same time 55°F. If the difference of 3°F. was enough to influence the appearance of four individuals, why not others?

The animal during the first few days grows at the rate of a zoöid a day, the photograph reproduced in Figure 3 showing the appearance of a colony three days old. These young colonies are extremely difficult to narcotise and fix; after five hours constant attention the youngest zoöid of the colony reproduced in Figure 3 suddenly retracted and refused to be coaxed out again in spite of all my exertions! An adult colony presents no difficulty of this sort.

I have two colonies that are still alive and healthy; the larger one is now composed of nineteen individuals. Although there is plenty of weed in the tank they prefer to float upside down on the surface film of the water. They are now beautifully "tame"; constant familiarity with pipette and tweezers has evidently bred contempt, for nothing short of pushing a zoöid in with a dissecting needle will cause it to retract.

ARTHUR C. BANFIELD.

PHOTOGRAPHY.

By C. E. KENNETH MEES, D.Sc. (LOND.), F.C.S.

COLOURED SILVER IMAGES.—All photographers are aware of the coloured or "warm-tone" images which are produced upon slow plates by restrained development, accompanied by an exposure considerably greater than that required for black tones; but the cause of these coloured images is not generally understood. That the colour is not body colour is shown at once by the fact that the colour by reflection is quite different, usually complementary, to that given to the transmitted light. No arrangement or structure in the film is visible, so that interference-colours are not possible, while the variety of tones produced would seem to exclude the colours of turbid media.

In the investigation of the subject by Schaum and Schloemann, these authors came to the conclusion that the

colours are due to the optical resonance of the small particles, these particles being of the same order as those obtaining in colloid solutions.

For gold gelatine solutions the theoretical relation between the size and separation of the particles and the colour of the solution, which was worked out by M. Planck, was experimentally confirmed by Kirchmer and Zsigmondy, but with silver suspensions the particles are larger and the separations smaller, so that the colours are less pure and their maxima not so sharp; the silver suspensions are, however, affected by swelling and drying in the way indicated by theory.

The condition for the production of the coloured silver images in development, instead of black deposits, is the precipitation of the silver from a solution of silver salt of considerable concentration (compared with the concentration of silver bromide solution in an ordinary plate during development). For this reason silver chloride has always given such "warm tones" with much greater ease than silver bromide; a small addition of ammonium carbonate to the developer being sufficient to produce a concentration of silver chloride in solution, from which finely divided silver will be precipitated. If, however, silver bromide be obtained in a sufficiently fine state of subdivision, the same result can be obtained without the use of silver chloride. Plates prepared with very fine grained silver bromide will give "warm tones" with ammonium bromide and ammonium carbonate in the developer.

The tones obtained range through browns to purples, carmine, and eventually yellow. When working along the lines indicated above, it seemed to be worth while to find out whether the addition of solvents of silver bromide to the developer would aid in the production of warm tones. With silver chloride and with ordinary silver bromide plates the addition of such solvents to the developer usually induced a general heavy fog, often coloured, all over the plate. The very fine grained bromide plates, however, proved resistant to this general fog, which could be prevented by the addition of a small amount of soluble bromide.

The addition of small quantities of sodium thiosulphate ("hypo") to the developer was found simply to assist in the production of warm tones; but when thiocarbamide was tried an entirely new range of colours was produced, "cold tones" being obtained instead of "warm tones." These colours ranged from dead blacks through blue blacks and blues to violets, and eventually carmines.

Most of the toning methods for lantern slides and bromide papers depend upon the conversion of the silver image into some coloured compound, but a method suggested by Mr. Welborne Piper for obtaining warm tones on fast plates is to bleach the image with bichromate and hydrochloric acid, thus obtaining an image of silver chloride, and then to develop this with a developer containing ammonium bromide and ammonium carbonate.

In the *Kolloid-Zeitschrift* for October, A. Neugschwender publishes a new method of obtaining warm tones, and a trial of the process seems to show that it is possible to produce very fine results by means of it. If silver nitrate is added to potassium ferrocyanide and the resulting precipitate of silver ferrocyanide is treated with stannous chloride, and then ammonia is added to the mass, a deep brown solution is produced, which, after some standing, or immediately on boiling, produces a dark brown precipitate. If the dark brown precipitate is treated with concentrated hydrochloric acid a yellow solution is obtained which goes green, and finally blue. The brown colour is removed from the solution by filtration through parchment, and is also precipitated by acids. With potassium cyanide it is first precipitated and then re-dissolved with the formation of the double cyanide.

All the evidence goes to show that the brown solution contains colloidal silver, which is precipitated as a hydrogel by acids or boiling. Now if a negative, lantern slide or bromide print, be taken and treated with a solution of potassium ferrocyanide the image is converted into silver ferrocyanide. If the plate or print be then soaked in a solution of stannous chloride, washed, and immersed in ammonia solution the image changes from the white of the ferrocyanide to a bright brown colour of an intensity much greater than that of the original.

For negatives this forms an intensification process of strength intermediate between the mercury and the uranium processes. For lantern slides and bromide paper the tones produced seem very satisfactory.

The author has investigated the effect of modifications in the process. No advantages appear to result from the use of other silver salts than the ferrocyanide, other tin salts than the chloride, or other reducing agents than stannous chloride; the use of other alkalis than ammonia, however, results in a modification of the colour produced. Caustic soda produces a chocolate brown colour instead of the bright burnt-sienna colour obtained with ammonia, while caustic potash gives a coffee colour. The addition of hydrochloric acid produces an ugly yellow colour, but this looks as if it would give fine results if toned with gold. This, however, has not been tried.

THE "REVERSAL" OBTAINED WITH THIOCARBAMIDE.—In 1890 Major-General Waterhouse showed that if thiocarbamide be added to a developer a reversal is obtained; that is, on development a positive is produced instead of a negative. The image resulting is of a brown colour and evidently contains colloidal silver. No explanation appears to have been offered of this reversal but it does not seem to be very difficult to suggest one. In the first place the probable cause of the general production of fog on the unexposed portion of the plate seems to be the inoculation of the silver bromide grains with a "germ" of silver sulphide. In the same way a preliminary soaking of a plate in gold chloride solution produces a "germ" of gold which causes the plate to blacken all over at once when immersed in a developer. The deposit produced with thiocarbamide is brown in colour, because thiocarbamide is a solvent of silver bromide and the silver consequently deposits from a solution rich in salt.

Now this deposition of silver sulphide "germs" is prevented by the presence of a very small amount of soluble bromide, which greatly lowers the solubility of the silver bromide, and consequently the rate of deposition of the silver. When a developer containing thiocarbamide is poured on to an exposed plate it first begins to develop the ordinary negative image. In doing this it impregnates the film *wherever the image is developed* with the soluble bromide formed as one of the products of development. Consequently, when the general deposition of the brown silver begins the places where the most soluble bromide has been formed, that is, where the greatest exposure was received, will receive the least deposit, so that we shall get a positive.

This explanation is confirmed by the fact that the positive image is always a little indistinct in outline, and that there is always a tendency for such objects as a church spire projecting into the sky, which should appear dark, to fail to develop owing to the diffusion of the soluble bromide sideways in the film.

PHYSICS.

By W. D. EGGAR, M.A.

A NEW METHOD FOR PRODUCING HIGH TENSION DISCHARGES.—Professor Ernest Wilson and Mr. W. H. Wilson exhibited to the Physical Society, on October 28th, a new method of operating the primary of an induction coil. An alternating or continuous current is allowed to surge into an inductance coil, which forms with a condenser a low frequency oscillating circuit. There is a contact-maker driven by a small motor, which first connects the inductance to the supply. When the contact is broken the whole energy of the inductance finds its way into the condenser, which is at this moment mechanically connected to the primary of the spark coil, the inductance coil being simultaneously short circuited. The condenser then discharges itself rapidly

through the primary, forming a high frequency oscillatory circuit, and the secondary of the spark coil transmits this energy to the X-ray tube, or aërial. It is claimed that this method of obtaining a high tension discharge has many advantages, rendering it specially suitable for wireless telegraphy as well as X-ray work.

TECHNICAL OPTICS.—The London County Council Education Department have circularized members of the optical trade in London, asking them to state their views as to the need for an Opto-technical Institute in London, and to indicate what advantages they would expect to obtain for themselves and their employés from any facilities that might be provided; also whether in their opinion the expenditure of £30,000 for a building would be justified. The proposed new institution would accommodate three hundred to four hundred students, and day and evening classes in all branches of optics would be provided. It seems probable that a satisfactory answer may be given, and that British optical work, which is making great efforts to regain the position rightfully belonging to the country of Newton and Dollond, may be greatly benefited by the establishment of such a technical training school.

SEISMOLOGY.

By CHARLES DAVISON, Sc.D., F.G.S.

THE MESSINA EARTHQUAKE.—A summary of two preliminary reports on this destructive earthquake was given in "KNOWLEDGE" for last February. Since then several valuable memoirs have been published. Dr. Mario Baratta's final report is one of the most noteworthy. He agrees with other seismologists in assigning a submarine origin to the earthquake, but points out that there were two distinct foci, both under the Straits of Messina; one at their northern entrance, the other farther south, near Reggio. Dr. Baratta shows also that the northern focus was that in which the second great earthquake of February 5th, 1783, with its accompanying sea waves, originated, while the sea waves which followed the recent earthquake proceeded from the southern, or Reggio, focus.

The Royal Commission appointed by the Italian Government has also issued a valuable report. The chief object of the commission was to determine the exact sites on which the ruined towns should be re-built, if re-built at all. It is now well known that earthquakes are most destructive to houses built on soft earthy ground, especially on sloping ground, while they cause comparatively little injury to those built on hard compact rock. Notwithstanding the objectionable nature of the soil round Messina and Reggio, these two towns are to be re-built on their original sites. The presence of the harbours renders this compromise necessary, but no permanent dwelling houses will be allowed on loose sloping ground, or within about one hundred yards of the shore. In other districts, the sites of many villages will be wholly or partially abandoned.

DESTRUCTIVENESS OF CALABRIAN EARTHQUAKES.—Professor G. Mercalli has compiled a list of destructive earthquakes which have visited the provinces of the Basilicata and the two Calabrias since the beginning of the sixteenth century. The total number of such earthquakes is thirty-eight, and the number of deaths due to them in these provinces alone is not less than 76,000. This figure is given on the supposition that during the Messina earthquake 17,815 persons were killed at Reggio, or about 24 per cent. of the population. Much higher death-rates were, however, attained in other earthquakes, the highest known being 77 per cent. at Terranova, in the Calabrian earthquake of 1783; 71 per cent. at Montemurro and 50 per cent. at Saponara, in the Neapolitan earthquake of 1857; and 47 per cent. at Altilia in the Calabrian earthquake of 1638. Professor Mercalli attributes the relatively high death-rates in towns to the loftiness of the buildings, the crowding in individual houses, and the narrowness of the streets in the older parts of the towns. Destructive earthquakes, he notices, occur in groups, during which the earthquakes take place at short intervals apart, but always with a sensible displacement of the focus, and therefore of the area of damage. There is also a migration of activity from province to province. In the seventeenth and eighteenth centuries, central and southern Calabria were most affected, in the nineteenth century, Calabria Citra and the Basilicata, while in the present century, southern Calabria again furnished most of the victims.

EARTHQUAKES IN GREECE.—In the last volume of the *Annales* of the National Observatory of Athens, Professor D. Eginitis describes the earthquakes recorded in Greece during the five years 1904–1908. He considers that this period was one of comparative seismic calm, for the average number felt was only one hundred and fifty-eight, while in the preceding five-year periods it was five hundred and thirty-one and three hundred and twenty-one. In the year 1907, only seventy-three shocks were observed, and they were all of slight or moderate intensity, none of them being strong enough to cause damage to buildings. After the close of 1908, that is, after the occurrence of the Messina earthquake, the shocks, however, show a distinct increase both in frequency and intensity. As usual, the local earthquakes were more often felt in Zante than elsewhere one hundred and forty-two out of six hundred and twenty such shocks having originated under or near this island.

ZOOLOGY.

By PROFESSOR J. ARTHUR THOMSON, M.A.

WERE DINOSAURS VEGETARIAN?—It has been very generally supposed that the great Sauropod Dinosaurs were purely herbivorous animals, which fed on the algae and other aquatic plants in the streams and marshes beside which they lived. The small, rake-like, imperfectly-rooted teeth with which the front of the jaw alone was supplied, were not adapted for cutting or grinding, but may very well have served for gathering in masses of floating vegetation, which, it is assumed, were pressed free of water in the arched palate, and swallowed without mastication. The pebbles, presumably gastroliths, found along with the remains give support to this view.

Tornier, however, recently suggested that the small size of the abdominal cavity relative to the bulk of the animal points to a more nutritious diet than aquatic vegetation. The ladle-like formation of the lower jaw, and the broad, flat muzzle seem to him to indicate that small, soft aquatic animals formed at least part of the food.

Now Dr. Versluys puts forward the interesting theory that these giant reptiles were fish-eaters, and many details of their structure appear more intelligible on this theory than on any other. The upper jaw in some forms, *e.g.*, Diplodocus, was apparently movable, and this would enable the animal to open its mouth quickly and snap at a passing fish, which would be swallowed whole. The long, muscular, and extremely mobile neck, the small head, the mobile jaws, and the trap-like teeth must have combined to make a very formidable fishing apparatus, which could be used with good effect even against considerable resistance, as under water. It is also suggested that Diplodocus may have used its long whip-like tail to lash the water, and thus bewilder its intended prey.

INHERITANCE OF "ACQUIRED CHARACTERS."—Dr. F. B. Sumner in the course of his researches on white mice has carried out a series of experiments which are of great interest. He reared one set of mice in a warm room (about 21°C), and another set in a cold room (about 5°C), to determine the effects of the difference of temperature on their growth. He found that the mean length of tail, foot and ear was greater in the warm-room mice than in the cold-room mice. The next point to be determined was whether and to what extent these somatic modifications reappeared in the offspring. The experimenter reared one hundred and forty-

one descendants of the warm-room mice, and one hundred and forty-five descendants of the cold-room mice in a common room in which they were all exposed to identical temperature conditions. Yet the same differences which had shown themselves in the parents showed themselves also in the second generation, manifested especially in the earliest series of measurements, taken at the age of six weeks. Of course this reappearance of the parental modifications in the offspring is open to many interpretations. Some of these Dr. Sumner discusses, but he maintains that no decisive verdict can be given in the meantime, and he proposes to carry out a sufficient series of experiments to test every possible hypothesis.

PROCESSION CATERPILLARS.—Mr. Edwards has made a fine study at Arcachon of the well-known processional larvae of *Cnethocampa pinivora*, familiar to many visitors to the Riviera. The procession is always single file, the larvae being arranged in head-to-tail contact. The length of the procession varies greatly, but only three were found which numbered over a hundred individuals.

Experiments were made to determine how far the primite or the first in the file may be regarded as the true leader. It was found that any larva might function as primite, but that one individual usually retained the post, and was apparently capable of taking a certain initiative in the selection of a path, burrowing for pupation, and forming a circulating mass. Light and surface seem to be the determining factors in the choice of a path. A whole procession was cast into shade, and a reflected ray of light was cast under the head of the primite. The whole procession followed the ray, though only the primite could have been influenced by the stimulus.

Before pupation, the procession breaks up into a mass in which the larvae are continually moving about among each other without advancing from the same spot. This formation was observed at other times also, and when the procession reformed without pupation, the same larva took the lead, and followed the outward bound thread back to the nest. Artificial threads, or threads of other processions placed in his path, were always rejected. Artificial breaks in the thread did not prevent joining up if the distance between the two parts of the procession was not great. Head to tail contact seemed of more importance in keeping the procession together than the thread. Before pupation the mass formed in a position apparently selected by the primite, which was observed to test the consistency of the sand with his mandibles. The whole mass rotated until a gradually deepening depression was formed in the sand. All the while the larvae were depositing their silken threads, until a regular network was formed, and in this the loosened sand became entangled. The larvae seemed to aid in the process by displacing the sand with their mandibles, and in a few days the whole mass was buried to a depth of several inches. Pupation was completed nineteen days after burrowing. Larvae which had become isolated buried themselves by means of their mandibles. The facts seem to the observer to warrant the conclusion that, though the individuals of a procession may act alike when influenced by the same stimuli, yet each larva is capable of independent action, and that therefore the procession cannot be said to act in any real sense as a single individual.

REVIEWS.

ASTRONOMY.

Facts and Fallacies regarding the Bible.—By WILLIAM WOODS SMYTH. 192+viii. pages. 10 illustrations. 8-in. × 5-in.

(Elliot Stock. Price 3/6 net.)

The key to this book is given in the Preface by the Author in these words: "This work accepts without qualification the modern ascertained facts regarding Matter, Life, and Mind, and their genesis, as interpreted by our highest authorities; and exhibits them, in relation to the Bible, as the natural bases of its own revealed facts and doctrines, which they illustrate, confirm, extend."

The author strongly criticises the statements and views of Dr. Driver and others of the "Higher Criticism" school, concerning the first chapter of Genesis: he adduces abundant facts to refute many of those views, and argues in a logical manner from the astronomical, geological, and natural history points of view. Great stress is laid upon the use of the Hebrew voice Hiphil, which is causative and is used to signify unfinished, continuous, progressive creation affording evidence of the power of environment in the course of evolution. But space will not permit us to enter into the arguments raised in this great controversy between men of science and learning; these philosophers mainly live for the present rather than for the future existence.

The author is evidently well read in the wide subject he deals with, and qualified to refute the present-day scepticism regarding the accuracy of statements as revealed in the Bible. He marshals his facts and refutations with telling effect, and states his arguments with convincing truth.

The book is well printed with large type on light non-glazed paper, and is very free from printer's errors. But why use the word *meteorolites*? And why no index? We think the Book should be widely read and studied.

B.

Round the Year with the Stars.—By G. P. SERVISS. 148 pages. 60 plates. $8\frac{1}{4}$-in. × $5\frac{1}{4}$-in.

(Harper & Brothers. Price 5 - net.)

A useful book to stimulate the minds and imaginations of many amateur followers of the starry heavens. The book will be of little use to those amateurs who possess a telescope, ever so small, as other more useful and conveniently arranged aids to the telescope already exist. But the author's intention is declared in the preface:—"This book represents an attempt to cultivate the love of the stars" without optical aids, and "turn his (the reader's) eyes to the sky, and open his mind to its plain teachings and its supernal inspirations."

The author has dived extensively into the domains of Greek and Arabic mythology and nomenclature, which alone tend to excite lively imaginations and poetic fancy, though no acquaintance with practical astronomy may result. The book is suitable for those who can spare the time to look at the stars and allow their minds to wander freely to the limits of poetic license. The book has large type and is light to handle; the maps show the positions of the chief visible stars at different times of the year.

We demur to accepting one or two of the pronunciations on pages 141 and 142.

B.

Stars Shown to the Children.—By E. HAWKS. 120+xii. pages. 50 plates. $6\frac{1}{2}$-in. × $4\frac{1}{2}$-in.

(T. C. and E. C. Jack. Price 2/6 net.)

This little book is the ninth of the "Shown to the Children" Series, edited by L. Chisholm, and this series has been adopted by the London County Council as prize books. Mr. E. Hawks is an enthusiastic amateur, and honorary secretary of the Leeds Astronomical Society. The book is divided into thirty-three chapters. In the first eighteen chapters the Sun, Moon, Planets, Comets, and Meteors are separately dealt

with, chapters xix. to xxviii. refer to the Stars, and the last five concern the Astronomers, Observatories, and Instruments. To the Sun nine plates are appropriated, to the Moon eight, to the Planets seven, Comets and Meteors have five, various subjects have eight, leaving only thirteen plates relating to the subject title of the book.

We see no objection to all these subjects being treated lightly in an elementary manner in a prize book intended for school children, usually under thirteen years of age; on the contrary, we think it better to introduce the young reader to the most prominent objects in the sky, and we see no reason why more plates of telescopic objects should not be given at the expense of certain non-stellar plates that might be omitted. But we object to the title as being inappropriate to a book in which only ten out of thirty-three chapters, or thirty-eight pages of one hundred and twenty pages are devoted to the *Stars*. Should another edition be called for, which we would heartily welcome, we hope to see the title changed.

To give an account of the chief objects visible in the sky in so few pages is not quite an easy thing to do, but Mr. Hawks writes in an interesting and pleasant manner, which should entrance the young reader's attention. Nor have we any word to say, save of praise, for the abundant richness in the number and quality of the plates—thirty-three of these are the work of Mr. Hawks—for the printing and paper, and for the strong and suitable binding.

We recommend the book to parents and teachers as a suitable present to their young folks.

B.

CHEMISTRY.

The Elements: Speculations as to the Nature and Origin.—By SIR WILLIAM A. TILDEN, F.R.S. 109 + xi. pages. 7-in. × 4½-in.

(Harper & Brothers. Price 2 6 net, or in Leather, 3 6 net.)

The wonderful results that have been obtained during the last ten years in the investigation of the phenomena of radio-activity, and the proof that one element, at least, undergoes decomposition into another, lend strong support to the old idea of the evolution of the elements. The scientific literature upon the subject is already voluminous, and, every day, additions are made to it, the accounts of which are, as a rule, only published in chemical and physical journals. It was, therefore, a happy notion of the publishers to include in their "Library of Living Thought" a small volume giving an outline in simple language of the present position of scientific opinion on the subject, and the reader may be congratulated upon having access to the fascinating story of the relationship of the elements, told by such a master of simple narrative as Sir William Tilden. The speculations in the last chapter are full of suggestion, and indicate the lines upon which the future development of the modern version of the "philosopher's stone" may be expected.

The Fats.—By J. B. LEATHES, M.A., M.B., F.R.C.S. 138 + x. pages. 9½-in. × 6-in.

(Longmans, Green & Company. Price 4 - net.)

The chemistry of fats is far too wide a subject to be compressed effectively within the limits here assigned to it, but for the special purpose for which it has been written the book will be found of use. Thus, the biologist who needs a concise work of reference to the chemistry of this important group of bodies, and the chemist who is anxious to know the directions in which biology is applying chemical results, will there find what he seeks.

An excellent, though necessarily brief outline is given of the composition of fats, the physical and chemical methods of examining them, and their rôle in physiology, and the book concludes with a bibliography and a good index.

As the work is obviously intended to be a reference handbook, the bibliography should certainly have been made more complete. For example, to cite one of the many omissions, reference is made in the text to the important results of Heinz, but the worker who wishes to consult the original papers will fail to find any mention of the journals in which they were published.

More attention might also have been given to the question of terminology. Thus the oxidation products of unsaturated fatty acids are in some places described as "oxy" acids and in others as "hydroxy" acids, the latter, of course, being the correct term. Again, the term "linoleic" acid is used to describe the acid usually known as "linolic" acid, whereas the former name is usually given to the whole of the mixed fluid fatty acids from linseed oil. There are also a few small inaccuracies in the text. Thus it is stated (p. 87) that the bichromate method of estimating glycerin is more liable to error than the permanganate method, whereas the former method has not only been "proposed," but is also in daily use in many laboratories, and gives more accurate results than the permanganate method.

Again, it is incorrect to describe the insoluble bromide obtained from linseed oil as a "hexabromide." This compound was first prepared and described by Hehner and the present reviewer, and the whole of the evidence pointed to its being the bromide of a mixed glyceride—certainly not a hexabromide.

But these points are trifling, and do not materially detract from the value of a book which every student of the subject will be glad to have in his library.

It may be added that, like the other monographs on bio-chemistry in this series, it is clearly arranged and printed in type that is easy to read.

GEOGRAPHY AND GEOLOGY.

Cambridge County Geographies—Lanarkshire.—By F. MORT, M.A., B.Sc., F.G.S. 168 + viii. pages. 46 figures. 5 maps. 5-in. × 7¼-in.

(Cambridge University Press. Price 1 6.)

This volume initiates the extension of the excellent series of Cambridge County Geographies to Scotland. Lanarkshire is essentially Clydesdale, and for considerable distances the county boundary coincides with the watershed of the famous river. The county owes its importance to coal and iron conjointly with easy access to the sea by way of the Clyde. With one-thirty-fifth of the area, Lanarkshire contains between one-quarter and one-third of the population of Scotland, although much of the county is bare moorland. It is by far the most densely-populated county, having 1,524 persons to the square mile. It is, of course, dominated by Glasgow, which owes its prosperity to the unrivalled natural resources of the Clyde basin, and to its position as the gateway of the trade of the area. It is impossible within the limits of a short review to mention a tithe of the topics discussed in this extraordinarily interesting little book. Mr. Mort has accomplished his task with a great measure of success, and has set an excellent example for the other forthcoming Scottish volumes. Incidentally also he sets before us very vividly the vast scope of modern geography. Hardly any aspect of the county of Lanarkshire in relation to its inhabitants has escaped remark. The illustrations, maps, and diagrams are good and informative, although the absence of an index is to be regretted. The fine paper, clear typography, and neat binding render the volumes of this series a pleasure to handle.

A History of the Mineral Waters and Medicinal Springs of the County of Essex.—By MILLER CHRISTY, F.L.S., and MISS MAY THRESH, with a Critical Note by W. H. DALTON, F.G.S. Essex Field Club Special Memoirs. Vol. iv. 73 pages. 7 illustrations. 5½-in. × 8¾-in.

(Essex Field Club, and Simpkin, Marshall & Co. Price 2 6 net.)

This book is a reprint, with additions, of a paper read before the Essex Field Club in 1907. Many so-called mineral springs occurring in Essex have been described in certain ancient and curious works, of which a good annotated

bibliography is given, and from which many interesting extracts have been incorporated in the text. All recorded mineral and medicinal waters within the county have been investigated and many new analyses made, with the result that only three occurrences can be classed as true mineral waters. These owe their small medicinal properties to the presence in them of magnesium sulphate. This salt occurs to the extent of 19·73 parts per 100,000 in the water of the Hockley Spa Well. These waters have little or no medicinal value, and the wonderful cures reported to have been effected by them were as much due to faith as to a period of simple and orderly living on the part of the patients whilst taking the waters. Mr. W. H. Dalton points out that the great majority of the springs occur within the area of the London Clay. Their waters are doubtless derived either from sandy seams in that formation, or from its contact with superficial gravels, the mineral constituents being obtained entirely from the clay. The authors are to be congratulated on having presented an exhaustive account of an interesting subject—a model of the kind of investigation which should be carried out under the auspices of a local scientific society.

Extinct Monsters and Creatures of Other Days.—By the Rev. H. N. HUTCHINSON, B.A., F.R.G.S. 329 pages. 55 plates. 113 figures in the text. 6-in. × 9-in.

(Chapman & Hall. Price 10 6 net.)

In this volume there have been combined together two old and tried friends, "Extinct Monsters" and "Creatures of other days." These books by the Rev. H. N. Hutchinson are so well known to all who have studied geology, that it is only necessary to point out the changes that have been made. Some chapters from the second book on fossil fish and crocodiles, and the chapter on "Relics of the Pleistocene Period," have been omitted and a few of the creatures from "Extinct Monsters." New photographs of Anomodonts, sent by Professor Amalitzky, have been added. Dinosaurs come in for more attention, the elephant's ancestors are considered, and the great birds and sloths from South America. The style in which the book is written and the striking illustrations make it eminently suitable for a Christmas gift to any boy or girl who has a taste for natural history.

MEDICINE.

The Brain and Voice in Speech and Song (Harper's Library of Living Thought).—By F. W. MOTT, F.R.S., M.D., F.R.C.P. 112 pages. 18 illustrations. 7-in. × 4½-in.

(Harper & Brothers. Price, cloth 2 6 net; leather 3 6 net.)

There is always a peculiar pleasure to be derived from the study of a work written by one who has a really first-hand knowledge of his subject—a pleasure which we have experienced at almost every page of the book now before us. Dr. Mott is one of the greatest authorities on the structure and function of the brain, and when he tells us of the cerebral and psychic mechanisms of the voice and speech we know that we are getting the very best information obtainable, and are getting it first-hand.

The early chapters are devoted to a description of the Anatomical Structure and Mechanical Action of the Vocal Instrument. This is a very difficult matter to make clear without the introduction of technical terms, but here also we consider that the author has succeeded well. The book is illustrated by half-tone blocks from careful and for the most part original drawings, and is written in excellent style. It is one of a series of dainty little books published by Messrs. Harper, and should prove of especial value to singers and public speakers, as well as to teachers of voice production. To all interested in the study of the physiological and psychical processes on which their being depends we cordially recommend it.

The Mental Symptoms of Brain Disease.—By BERNARD HOLLANDER, M.D. 237 pages. 7½-in. × 5-in.

(Rebman. Price 6 - net.)

Much valuable information regarding the function of the different parts of the brain has, as the author points out, been derived from experiments on animals. But with regard to the higher mental processes, the intellect and the emotions, such experiments are, for obvious reasons, practically useless. Yet it is these very processes that are deranged in that most terrible of all diseases—insanity. Little wonder, then, that until quite recently very little was known of the pathology and treatment of mental disease. But now, thanks to such works as that before us, our knowledge is rapidly increasing. The present volume contains relatively few original observations, but is mainly a collaboration from the original papers, in many different languages, of cases in which serious mental symptoms have been found, at operation or post mortem, associated with definite organic changes in the brain. The collection and classification of these cases represents an almost infinite amount of careful research, and the conclusions which the author justly draws from them are extremely striking. The whole work forms an important contribution to the study of this most difficult subject. In it the physical origin of insanity is demonstrated, and it is further shown that the different types of mental disease are frequently associated with changes in definite brain areas. The many examples cited, in which insanity has been cured by surgical operation, form perhaps the most convincing argument for the correctness of the author's conclusions.

PHYSICS.

A Text-Book of Physics.—By H. E. HURST, M.A., B.Sc., and R. T. LATTEY, M.A. 638+vi. pages. 9-in. × 6-in.

(Constable & Co. Price 8 6 net.)

Teachers of Physics will welcome this book. It supplies exactly what is wanted for students who are working at the preliminary scientific course required by the University of Oxford of all who desire to take honours in Natural Science; and it will be found equally suitable for Army candidates and Medical students, as well as for candidates for scholarships in Mathematics, for whom a sound elementary knowledge of Physics is essential. The mathematical treatment is elementary, but very clear and adequate, and the diagrams are excellent. In a subject which leaves little scope for originality of treatment, the authors have succeeded in reproducing the individual character of a class-room, presided over by an experienced and thoughtful teacher. A well-chosen collection of examination questions follows each chapter, and the book has an up-to-date appearance throughout. As an instance we may mention the simple diagram and explanation of the prismatic field glass in the chapter on Optical Instruments. Altogether it is a book to be recommended.

Experimental Elasticity.—By G. F. C. SEARLE, M.A., F.R.S. 187+xvi. pages. 9-in. × 6-in.

(Cambridge University Press. Price 5 - net.)

Old Cavendish Laboratory students will remember the MS instructions which the mathematician unaccustomed to practical work used to cling to as to a trusty pilot. Mr. Searle's long experience as a demonstrator has made him thoroughly familiar with the difficulties of the unpractical wrangler as well as those of the unmathematical medical student. To quote his own words, he has had "to discover why . . . a student obtains 537·86402 [no units mentioned] for Young's modulus, by an experiment on a brass wire, instead of 9·86 × 10″ dynes per square centimetre." Some of the reasons for this kind of result are given, and are followed by extremely valuable hints on practical work in Physics, which all students (and teachers) would do well to read and take to heart. This book contains first an account of the elementary mathematical theory of elasticity, with a rather full discussion of particular problems, followed by descriptions of a large number of experiments requiring for the most part simple apparatus. Each description is followed by a fully worked out practical example, which may serve as a model for students in the recording of their observations; and the book deserves a place in every Physics laboratory. It is to be hoped that the half-promised volumes on other branches of Experimental Physics will not be long in making their appearance.

ZOOLOGY.

Monograph of the Land and Freshwater Mollusca of the British Isles.—By JOHN W. TAYLOR. Part 17. Pages 225–304, and plates xvi. xvii. xviii. xx. xxi and xxii.
(Taylor Brothers. Price 7/6.)

In the present part of his monograph Mr. J. W. Taylor completes his account of *Helix pomatia* the so-called "Roman snail" and gives a coloured map of its distribution in this country, with plates of some of the more interesting variations in the shell. The question of the introduction of this, our largest, snail into England by the Romans is discussed. The evidence which exists for the contention is that its shell is discovered among Roman remains, and that the animal is comparatively abundant in a living state near the site of several Roman stations. On the other hand the fact that an allied species is the one that occurs in Italy is brought forward, but this is not at all conclusive, as *Helix pomatia* occurs in France, and it is from there that the Romans would have probably brought it. The fact that its fossilised remains have been discovered in what are considered to be undoubtedly pre-Roman deposits, however, points to its being a true native of this country.

From Taylor's Monograph *of the Land and Freshwater Mollusca.*

A slime track of *Helix nemoralis*, eighteen feet in length.

From Taylor's Monograph *of the Land and Freshwater Mollusca.*

A necklace made by the peasantry of Donegal of the shells of *Helix nemoralis*.

Although considerable space is occupied with an enumeration of named varieties of shells which even many conchologists may think unnecessary, the monograph contains a great many matters of interest to zoölogists and to general students of nature. The present part is no exception, and we would allude to the descriptions of the habits of our common snail, *Helix aspersa*, the cavities which it wears in chalk and lime-stone rocks, its curious homing instincts and its use for food, which are topics about Mr. Taylor has much that is valuable to say. It has been doubtful also whether this snail is indigenous, but a number of investigators have shown that it occurs in the kitchen-middens of neolithic times.

The third species which comes in for consideration is the handsome hedge-snail, *Helix nemoralis*, and by the courtesy of the author we reproduce three illustrations which are typical of those in the monograph, showing a slime track of this species eighteen feet in length, a necklace of the shells, made by the peasantry of Donegal, and a photograph showing the haunts of a giant race of this species in Aran Islands, West Galway. The snails live in the fissures of the limestone in which also the true maiden hair fern grows in profusion.

The Prevention of Malaria.—By RONALD ROSS. 669 pages. 36 illustrations. 6-in. × 9¼-in.
(John Murray. Price 21s. net.)

Though zoölogy, under which heading this review is placed, can claim the credit of having forged the weapons for conquering what is, perhaps, the most important of human diseases, which kills on an average one million one hundred and thirty thousand people in a year, the subject of malaria is still, of course, a medical one. Every biologist knows the name of Ronald Ross, and in this book he summarises the whole question himself, and has collected together the opinions of a score or more other observers who have contributed chapters dealing with their own investigations and localities. We are given an outline of the history of the disease which goes back over two thousand years, of the discovery of the parasite, of the determination of the way in which infection takes place, of the recent history of its prevention, and of all the topics which bear on the parasite, the course of the disease, personal means of combating it, and its public prevention.

Major Ross must be proud of the work which he has achieved, although there is a note of bitterness in these words which are taken from his preface:—"The world requires at least ten years to understand a new idea, however important or simple it may be. The mosquito theorem of malaria was at first ridiculed, and its application to the saving of human life treated with neglect, jealousy and opposition."

From Taylor's Monograph *of the Land and Freshwater Mollusca.*

The haunt of a large variety of *Helix nemoralis* in the Aran Islands, West Galway.

X-RAYS.

By REGINALD MORTON, M.D.

MOST of the readers of this magazine will remember how, not only Europe, but the whole of the civilised world, was electrified by the announcement that a certain Professor Roentgen, of Wurzburg, had discovered a new kind of radiation, or light.

Up to that time the name of Roentgen, outside his own sphere, was little known; in a moment one might say his name became a household word, and it is safe to conclude will remain so, probably for many generations to come.

It is extremely doubtful if any purely scientific discovery was ever more quickly followed by a world-wide and lasting interest, or put to practical use, incidentally creating a very considerable industry, than this.

If a new science—radioactivity—was not then discovered, it was at least put upon a basis such as it never had before; it paved the road which led to the discovery of radium; brought strong and substantial support to the electron theory, which has since so established itself in all scientific minds that it seems strange to think that only so recently we were satisfied with atoms and molecules.

Leaving radium out of the question, our only means of obtaining the Roentgen rays is by the aid of a high tension electric discharge *in vacuo*. Who was the first to experiment with electric discharges in rarefied air or gases is unknown, but it does seem tolerably certain that it was very early in the last century. It was not, however, until about 1858 that Geissler made his first vacuum tubes. These were exhausted to about ·0025mm. of mercury, and under the electric discharge appeared to be filled with glowing gas, the colour and character of which varied with the particular kind of gas in the tube before exhaustion was commenced. Many of these are extremely pretty and form a familiar object at most scientific entertainments. Some years later Crookes began experimenting with tubes which, with the aid of greatly improved appliances, were exhausted to a much higher degree of vacuum. He observed with the increasing vacuum there was formed a dark space around the kathode, which increased in extent as the vacuum was increased. Concurrently the glowing gas which at first entirely filled the tube gradually disappeared. He also found at this stage new radiations were given off from the kathode, their direction being at right angles to the surface of emission. These he called "kathode rays," and he ascertained from their behaviour to a magnet that they carried a negative charge. Owing to their curious properties he was under the impression that he had discovered a fourth state of matter—"matter in radiation"—but he altered this view later on when he found that the observed phenomena were capable of a different explanation. By means of a concave kathode he was able to bring these rays to a focus, and by directing them on to some substances, such as fluor spar, calcined shells, and various others, he produced brilliant fluorescence and high temperatures if the action were prolonged. He further observed that when the exhaustion was carried to such an extent that the dark space reached out to the inner surface of the tube itself, the latter showed a beautiful green fluorescence, as well as the rise in temperature, and that these effects were intensified if the kathode was of concave form and the wall of the tube at or near the focal point of the latter.

There is not the least doubt that the X-rays were produced in these experiments, and the question may well be asked how it came that they were not observed by Crookes. The answer is very simple. Being invisible to our eyes they would easily escape observation in the ordinary way; then we must remember that Crookes confined his studies to what was going on *inside* the tube, and at that time there was no evidence of any kind to suggest even the possibility of radiations passing through the wall of the tube.

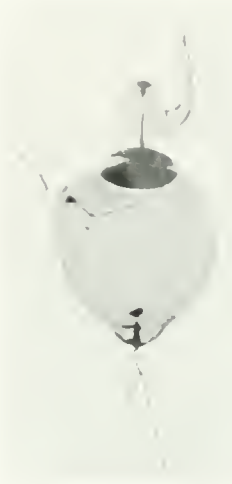
The publication of his famous paper soon started many other men experimenting in the same direction, and in 1892 Hertz announced that the kathode rays would penetrate thin metallic sheets if placed inside the tube, and within their path. Soon after this Hertz unfortunately died, but his experiments were carried on by his assistant Lenard, who in 1894 had a tube made with an aluminium window. This, when excited with an induction coil current, allowed the rays to pass outside the tube, and it was observed that they would also pass through other opaque bodies, such as paper, giving rise to fluorescence and phosphorescence in certain substances, and even affecting the sensitive salts of silver in a similar manner to ordinary light. The only mistake made by Lenard in these epoch-making experiments was in thinking that all these effects were due to the kathode rays alone.

In November, 1895, Roentgen, while experimenting with a Crookes tube, noticed that a small screen coated with barium platinocyanide fluoresced brilliantly in the proximity, though the tube was covered with cardboard and no light could be seen issuing from it. Following up this phenomenon he made out that this radiation came from a spot on the Crookes tube corresponding to the point of impact of the stream of kathode rays. He further ascertained that all substances were transparent to this new form of radiation, though in varying degrees, depending on the atomic weight of the

elements composing the substance. He also found that the radiation came in straight lines from the point of their origin, and that they could not be reflected or refracted, and were not in any way influenced by a magnet. It was now evident to him that he was in the presence of radiations hitherto unknown, and he forthwith set about an exhaustive study of their physical properties, so as to determine their exact nature, and so perfectly did he do this, that his original monograph has never been seriously added to up to the present time.

Having shown how any inequalities in density in any given object would be registered on a photographic plate, he at once recognised the immense importance of the discovery to surgery, and made his communication to the Physico-Medical Society of Wurzburg in December, 1895.

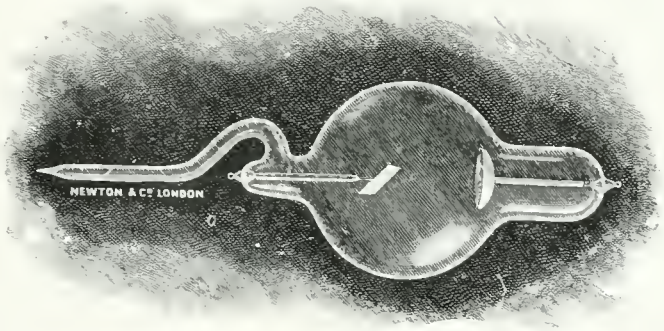
To describe in detail the various steps in the development of all the apparatus used in radiology would, and does, fill many a good-sized volume; as witness the excellent books written by several authors both here and abroad. We may, however, trace the evolution of the more important parts of the modern X-ray outfit without going beyond the space usually allotted to such an article as this.



By the courtesy of Sir William Crookes, O.M., F.R.S.

FIGURE 1.

The original Crookes's Tube.

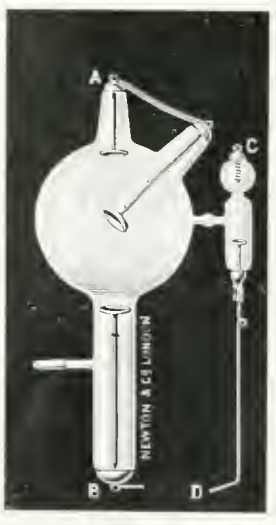


By the courtesy of Messrs. Newton & Company.

FIGURE 2.

The X-Ray Tube as improved by Professor Herbert Jackson.

In view of the fact that the whole science of radiology centres around the X-ray tube, and that everything else is subsidiary to it, we may very fitly consider this first. The original experiments were made with tubes of the well-known "pear" shape originated by Crookes. In these the kathode stream was made to impinge upon some part of the wall of the tube. (X-rays are produced when a stream of kathode rays are suddenly arrested by impact against a solid body.) The area of impact was always large—sometimes the whole of the large end of the tube showed the characteristic green fluorescence, showing that the X-rays were being given off from its whole area. Under such conditions the images of a fluorescent screen or a photographic plate were much blurred and generally indistinct. This was, of course, a very great disadvantage, and had no other form been available, it is safe to say that the science of radiology would have made very little progress. The first and the most important single contribution to the science was made by Professor Herbert Jackson, of King's College, London. He made a tube with a concave kathode, and mounted at or near the focal point, a flat disc of platinum which also acted as the anode of the system. The result was that all the X-rays came from this point, and gave sharp shadows with clear outlines as well as details of minute structure. Since Jackson made his original tube thousands have been made by many makers, but his general plan of construction has never been altered. In all tubes working under normal conditions, the tendency is for the vacuum to slowly increase. The generally accepted explanation of this is that the electrons become embedded in the walls of the tube, and so are put out of action. It is even believed that some are driven right through the glass. A certain number of those embedded can be restored to the body of the tube by heating the glass, and this was the only method of regenerating a tube in the earliest days of X-rays. The need for regeneration was owing to the fact that with the increase of vacuum the tube became so resistant that the electric current passed around the outside in preference to going through. Also the character of the radiation altered, so that a "hard" tube, as it is called, gave very poor images on the photographic plate, although the screen appearances were fairly brilliant; the reason being that the rays from a hard tube are less active in affecting the sensitive salts of silver, and hence it does not necessarily follow that a tube that gives a satisfactory image of the screen will give a good account of itself when used for registering the image on a sensitive plate.



By the courtesy of Messrs. Newton & Company.

FIGURE 3.

A modern X-Ray Tube.

Many devices have been brought out from time to time for regeneration of the vacuum in a convenient manner, and each has certain advantages. At the present time there seems to be an almost universal tendency among tube makers to employ some porous material such as asbestos, spun glass, leaves of mica, and so on. The material is enclosed in a small accessory bulb, the cavity of which communicates with that of the X-ray

tube and so arranged that when the resistance of the main tube rises beyond a certain degree the electric current passes through the small bulb, heating the porous material and causing it to give off some of its occluded gas. This passes into the large tube, lowers its resistance, and the current resumes its proper course.

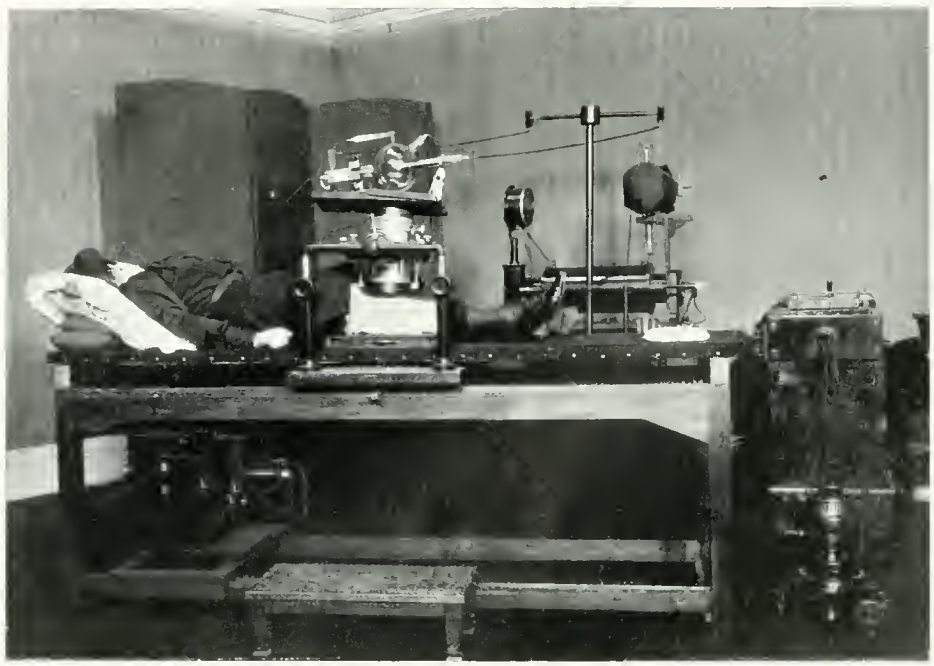


FIGURE 4.

Taking a stereoscopic radiograph of the Knee Joint.

The plate is passed under the knee by means of a tray sliding in the shallow box below. The X-ray tube in the black box below the couch is only used when a canvas top is substituted for the one here in use.

Apart from the presence of the vacuum regulator and the larger size that is now generally adopted, the modern X-ray tube does not differ in any essential particular from the original one designed and made by Professor H. Jackson. It is a pleasing duty to record the fact that he placed his important discovery freely at the disposal of anyone who wished to make use of it, and has not derived any more tangible benefit therefrom than the gratitude of X-ray workers throughout the world.

We must now turn to the improvements made during recent years in the coils and other high potential transformers. Before the days of the X-rays induction coils were rated or compared with one another according to their spark length. The maker of a big coil aimed at a certain spark length, and was not very particular as to how it was obtained: but the curious fact was, that when one of these big coils was used for X-ray work the results obtained were not always those expected, though it was generally agreed that large coils gave better results than small ones. About the beginning of the present century many coils were in use giving sparks of twenty, thirty or more inches in length: but as it was realised that a spark length of anything up to six or eight inches was sufficient to overcome the resistance of any useful X-ray tube, it became apparent that nothing was to be gained by increasing the sparking distance of the coil beyond a certain point, which has been found to be about fifteen inches. The only other thing to do was to increase the quantity of current available, and so drive a larger volume of current through the X-ray tube. As is well known, the current from any induction coil is not continuous, nor even unidirectional.

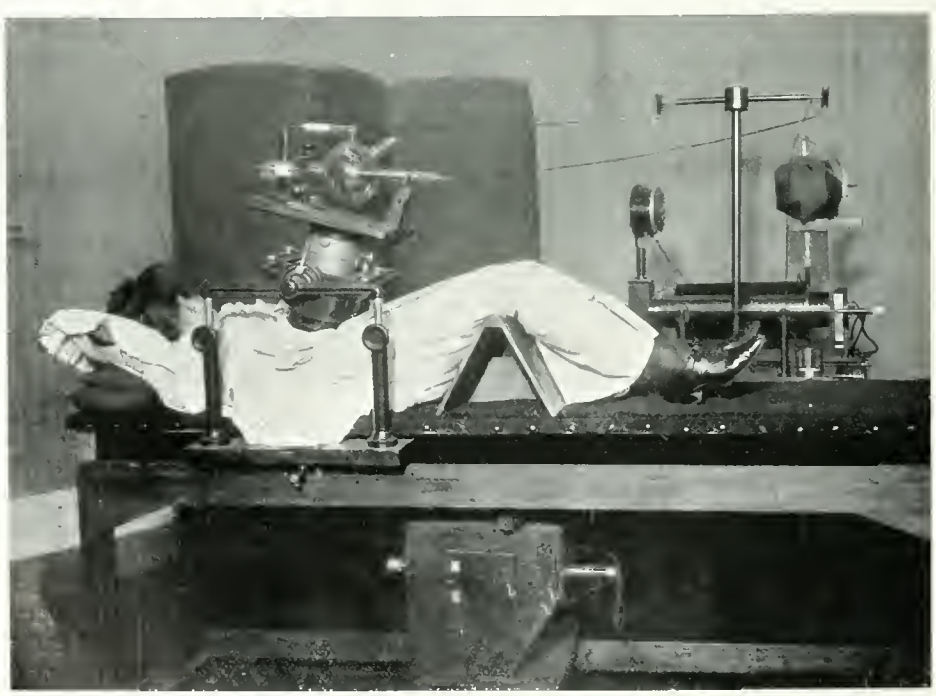


FIGURE 5.

Radiography of the Kidney.

The metal cylinder upon which the X-ray tube is mounted is pressed down into the abdomen, reducing its thickness and preventing all movement of the kidney itself.

It is an alternating current, but the waves of one sign preponderate over those of the opposite sign. Owing to the fact that the resistance of an X-ray tube to an inverse current is less than to a current in the right direction, it is necessary that these lesser and inverse waves be kept as small as possible—the reverse current having a very deleterious effect on the life and performance of the tube.

The first attempts at making these "heavy discharge" coils, as they were called, were not very successful; in fact, until quite recently, all these coils suffered from giving out too much inverse current, which, as we have seen, is very detrimental to the tubes.

The newest coils are a very great advance on anything of the kind that has been brought out before. Not only are they very economical of primary current for the very heavy secondary discharge they give out, but they are for all practical purposes quite free from inverse impulses.

FIGURE 6.

A radiograph showing a stone in the Kidney.

A very good way to test a coil is to allow it to discharge across an 8-inch air-gap, and take note of the readings of the measuring instruments in both primary and secondary circuits. Under such conditions a coil in the writer's possession gives a current of about sixty milliampères across the air-gap, and without any means employed to suppress any inverse current. The current in the

primary circuit amounts to about six ampères.

Such a discharge from a 12-inch coil was not possible ten years ago, and more recently it could only be obtained by using a larger coil and a large electrolytic interrupter, consuming from forty to sixty ampères in the primary circuit. Even here this discharge could not be taken advantage of except with the aid of valve tubes, to suppress or divert the enormous inverse current that was an invariable accompaniment of such discharges.

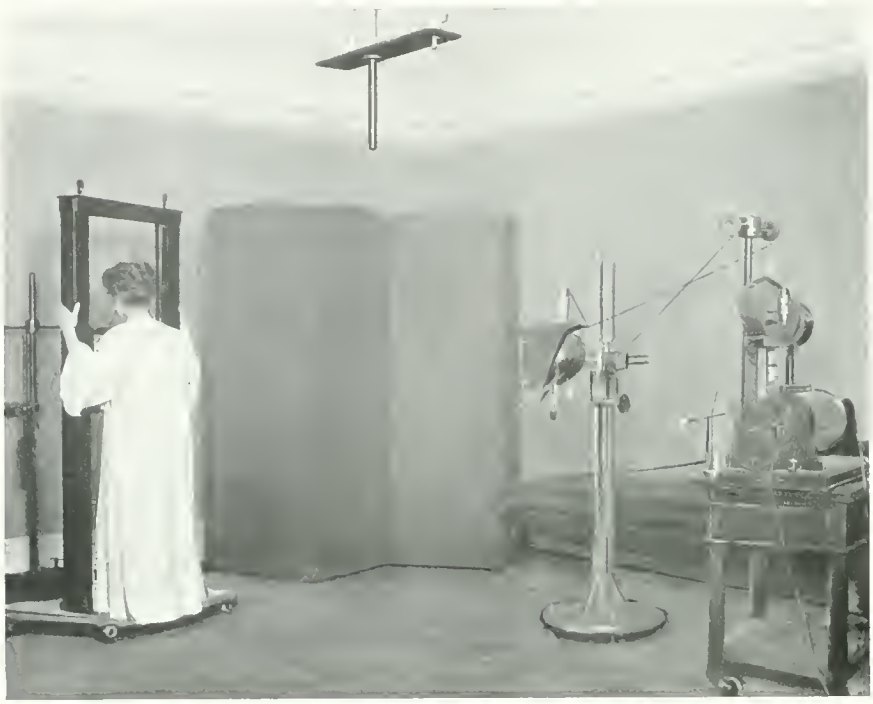


FIGURE 7. Teleradiography.

The tube is placed two metres from the photographic plate against which the patient stands. The shadow of the heart is but very slightly larger than the heart itself, and sufficiently correct for all practical purposes.

The very latest type of induction coil for X-ray work is what is known as the "single flash coil." The construction of this is such that a radiograph of almost any part of the body can be made with a single interruption. There are different ways of bringing about this effect. One maker makes the interruption by means of the explosion of a small cartridge; another secures the same end by suddenly releasing a wire that is held down in a vessel of mercury with a catch and against a spring in compression. The act of turning on the current draws back the catch and the wire rushes up by the action of the spring, and the circuit is broken at the moment the wire leaves the mercury.

This is the latest development of the induction coil, and in all probability it will have a far-reaching effect on the future of X-ray technique. It is not unlikely that in future we shall be regulating our exposures, not by so many seconds or minutes, but by the number of flashes or interruptions. What is now wanted is a means of giving any desired number at will, and, in all probability, this will be achieved before very long.

While in many ways the current from a coil is probably the most suitable for exciting X-ray tubes, the presence of the large amount of inverse current in the "heavy discharge" coils was such a great disadvantage that inventors set themselves to devise some means of producing a high tension current that was unidirectional. Who was the first to do this is a matter of some uncertainty, but the fact remains that the first practical instrument for this purpose was designed by Mr. H. C. Snook of Philadelphia. In this is a transformer constructed on the same principles as those used commercially, but so modified as to give out a current of anything up to one hundred thousand volts or more; the current is of course an alternating one. Incorporated in the instrument is a synchronous rotary switch, which

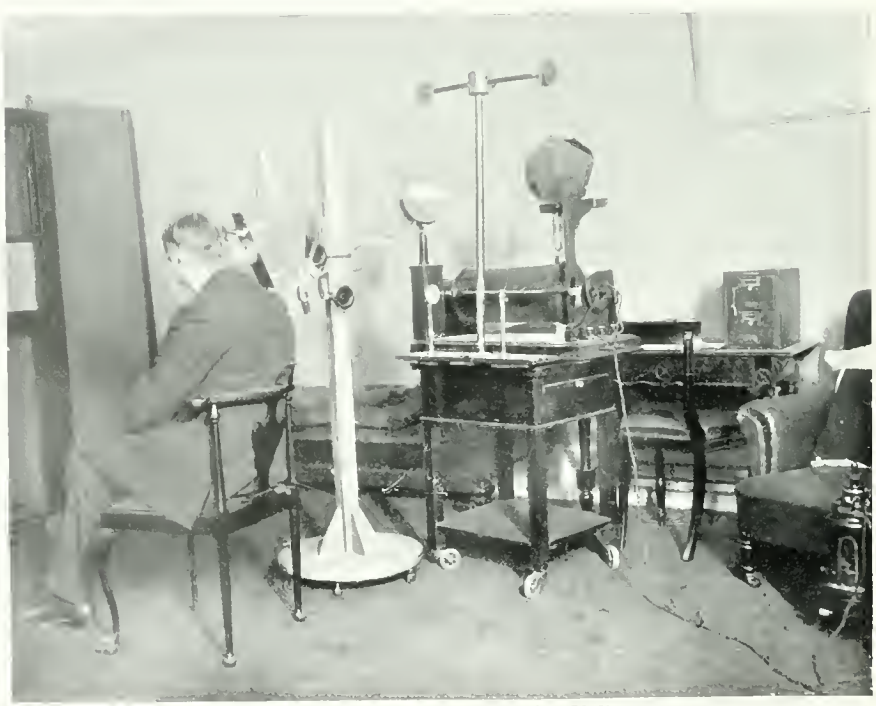


FIGURE 8. Treatment by the X-Rays.

The dose is measured by means of a "pastile" held in the tube shield.

automatically reverses the inverse waves. The result is a unidirectional, pulsating current that is entirely free from reverse waves, and the power of the apparatus is such that instantaneous radiography is readily carried out with it.

The drawbacks of this type of generator are the high cost, bulkiness, and noise, among others: but where great power is required it stands easily first. The greatly improved coils referred to above constitute the answer of the coil makers to the advent of the "high tension rectifier," as these machines are called. For a time these rectifiers had things all their own way, but this is no longer the case, and in the writer's opinion it is an instrument of the induction coil type that will ultimately prevail, that is, so long as our source of X-rays continues to be from a vacuum tube. The reason for this is on account of the peculiar character of the current given out. At the moment of interruption the current rises very suddenly to an extremely high tension, considering the output of the coil as a transformer of energy, and these impulses are eminently suitable for starting the electrons in action, as well as keeping them going, even when using a very small current. If we were to trace out the voltage of the coil current in the form of a curve, it would represent a mountain range of very high and steep peaks, while that from the rectifier is more like a series of low hills with broad bases and rounded tops. The latter type of current is not so suitable for exciting X-ray tubes, and at times they work very unevenly, especially with a small amount of energy.

Early in the days of radiology it was observed that the intervention of a diaphragm increased the definition and sharpness of the image, in the same way as in the photographic lens; then it was found that if instead of using a hole in a metallic disc the rays were made to pass through a metal tube a still further gain in sharpness was attained. So important is this, that the use of the tubular diaphragm is essential if the best radiographs are to be secured.

One of the most difficult matters to deal with is that of movement. Some patients have the faculty of keeping still for comparatively long periods of time. Very many others have not: the movements may be voluntary, but are frequently involuntary from nervousness, or tremors that are not under control. All the organs in the thoracic, abdominal, and pelvic cavities move to a greater or lesser extent with the movements of respiration, and this is an important factor in assisting the performance of their normal functions. Some of these movements are easily restrained, others are not, and many devices have been brought forward for this purpose; but the most generally useful of all is that in which the tubular diaphragm is mounted in a framework that passes across the patient, and is so arranged that it can be lowered down and made to press firmly upon the part it is desired to examine. Movement can in most cases be perfectly restrained, and the improvement in the quality of the resulting image is, compared with that taken without any diaphragm, quite startling. One of its greatest uses is in the examination of the kidney for calculus (see Figure 5). This organ under normal conditions moves about half-an-inch with each respiration, and if this is not restrained no clear image can be secured. With the compressor diaphragm this is easily done, the outline of the kidney is sharply defined, and its size, shape and position are definitely registered. As might be imagined the difficulty increases with the stoutness of the subject, but this is not nearly so important as it was, and a good result can be secured in nearly all cases, with a little care and trouble.

The use of this device necessitates the X-ray tube being above the patient, and it is not easy to make a preliminary inspection with the fluorescent screen which, in many instances, is all that is required. Where many have to be examined, as in the out-patient department of a hospital, it is a great convenience to have a couch with a canvas top upon which the patient is laid. The X-ray tube is fixed in a ray-proof box with an opening at the top through which the rays emerge, and this box can be moved in both directions so as to bring it under any desired part. The canvas being transparent to the rays we can, with the aid of the screen, look through the patient and frequently see all that is wrong: if there is any doubt, an X-ray plate is laid on the place and steadied with sandbags while the exposure is made. This is a convenient method for dealing with a number of cases, and the results are good enough for ordinary conditions.

THE SELBORNE SOCIETY AND PLANT PROTECTION.

THE question of Plant Protection has always been one of the objects of the Selborne Society, and for more than twenty years it has used its influence to prevent the wanton destruction even of hedgerow blossoms, and the rooting up of rare plants and ferns. The progress of modern civilization and the putting up of buildings is now making the question of Plant Protection a serious one, and there are other aspects of it which have to be considered. The more lowly plants are in danger of extermination, and it is most important, quite apart from the preservation of rarities, that tracts of land which are covered with common, but none the less interesting, plant communities should be preserved in their natural condition.

At a recent meeting of the Selborne Society a section was constituted to consider the best way of dealing with the problem. Dr. A. B. Rendle, M.A., F.R.S., Keeper of Botany in the British Museum (Natural History), has accepted the Chairmanship of the Section, and Mr. A. R. Horwood of Leicester Museum, has been appointed Recorder.

All those who are interested in the subject of Plant Protection, are invited to communicate with the Honorary Secretary of the Selborne Society, at 42, Bloomsbury Square, London, W.C.

THE MEASUREMENT OF PERSEVERATION AND ITS VALUE AS AN INDEX OF MENTAL CHARACTER.

By JOHN GRAY.

No science makes much progress until its votaries succeed in applying to its phenomena the methods of exact measurement. The sciences of chemistry and physics, after the introduction of exact methods of weighing and of measuring space, temperature and potential, advanced by leaps and bounds. We have good reason, therefore, to believe that the application of measurement would lead to a corresponding great advance in that science, by no means the least important, which deals with the evolution of man himself.

It will be convenient, in explaining the nature of the exact science of man, or, as it is usually called, anthropometry, to regard man as a machine, comprising a framework or structure and highly complex functions.

To measure the framework of man is a comparatively easy matter. With the graduated rod and the callipers we can measure statures, head diameters, and other dimensions of the body: and the weight can be measured with the weighing machine.

The simpler physiological functions, such as acuity of vision, colour vision, and other sensory characters can also be readily measured. But when we come to deal with the more complex physiological functions, those usually known as psychological, the difficulty greatly increases.

The value of measurements of psychological or mental characters is, however, so great that strenuous efforts have recently been made by anthropologists to discover some more or less exact methods. Intelligence, for example, plays so important a part in all the affairs of human life, that a fairly accurate method of measuring it would be of the greatest practical value to the educationist, to the military or naval officer, and to the business man, not to speak of the impulse which it would give to the science of man.

Most of the methods of measuring intelligence at present in vogue are personal estimates by teachers or others who are acquainted by long experience with the mental character of the person to be tested. These methods have been found to be only very rough approximations, as there is by no means good agreement between the results obtained by different observers.

The examination test is recognised as a good test of intelligence, but it involves other factors which have little or nothing to do with intelligence, and its correlation with success in after life is not very high.

It appears to me that simple and exact methods of measuring certain physiological properties of the brain which have a great influence on our mental growth, promise to give much more valuable results in the measurement of mental character than either the personal estimate or the examination test.

As an example of this I take the measurement of the persistence of a nervous current or disturbance in the brain after the external impulse has ceased.

For this purpose I have devised a simple apparatus by which flashes of coloured light can be thrown in rapid succession into the eye (see Figure 1).

The apparatus consists of a revolving mirror, the axis of which is horizontal, and which can be turned at any required speed by a handle and belt gearing. The speed at which the axis is rotating at any instant is shown by a speed indicator connected to its free end.

The mirror revolves in a dark box having windows of coloured glass directly above and below the mirror. Outside each window is a screen of white paper fixed at an angle of 45° to the plane of the glass, and illuminated by an electric glow lamp, or by other constant source of light.

A beam of diffuse light thus passes through the coloured glass of the window and impinges on the mirror. As the mirror revolves, the coloured reflected beam passes over an aperture in the side of the box, against which the eye of the person being tested is placed. When the reflected beam has passed over the aperture, the colour impulse on the retina ceases until the mirror has reached the position in which it reflects the next coloured beam of light into the eye.

The experiments of Shelford Bidwell, and of others, have shown that the sensation of a colour persists for a short time after the external impulse has ceased. If the duration of this persistence is equal to the time interval between two successive impulses from the revolving mirror, the colour will appear to be continuous. But if the persistence is less than the time interval, the colour will appear to flicker.

In order to measure the duration of the persistence in any given person all that is necessary is to ascertain from the speed indicator on the axis of the mirror, the exact number of revolutions which the axis is making when the flicker disappears. It is best to start very slowly, and gradually increase the number of revolutions of the mirror until the flicker disappears. The reading is taken from the speed indicator at this critical speed. The persistence of colour sensations in the person being tested is inversely proportional to the critical speed.

In order that observations made on different persons, and at different times, may be comparable, the illumination should be kept constant. Any variation in the luminosity of the coloured light will change the critical speed.

A different persistence will, as a rule, be found with different colours. It is desirable that the persistence should be measured with each of the three primary colours separately.

Experiments made by Nichols, Ferry, Abney,

Burch and Allen, show that colour blindness causes an abnormal increase of the persistence of the primary colour or colours to which the subject happens to be blind.

The same apparatus can thus be used as a test of colour blindness. After we have obtained sufficient statistics of the persistence of persons with normal colour vision, we may safely reckon any abnormal deviation from this average as an indication of colour blindness.

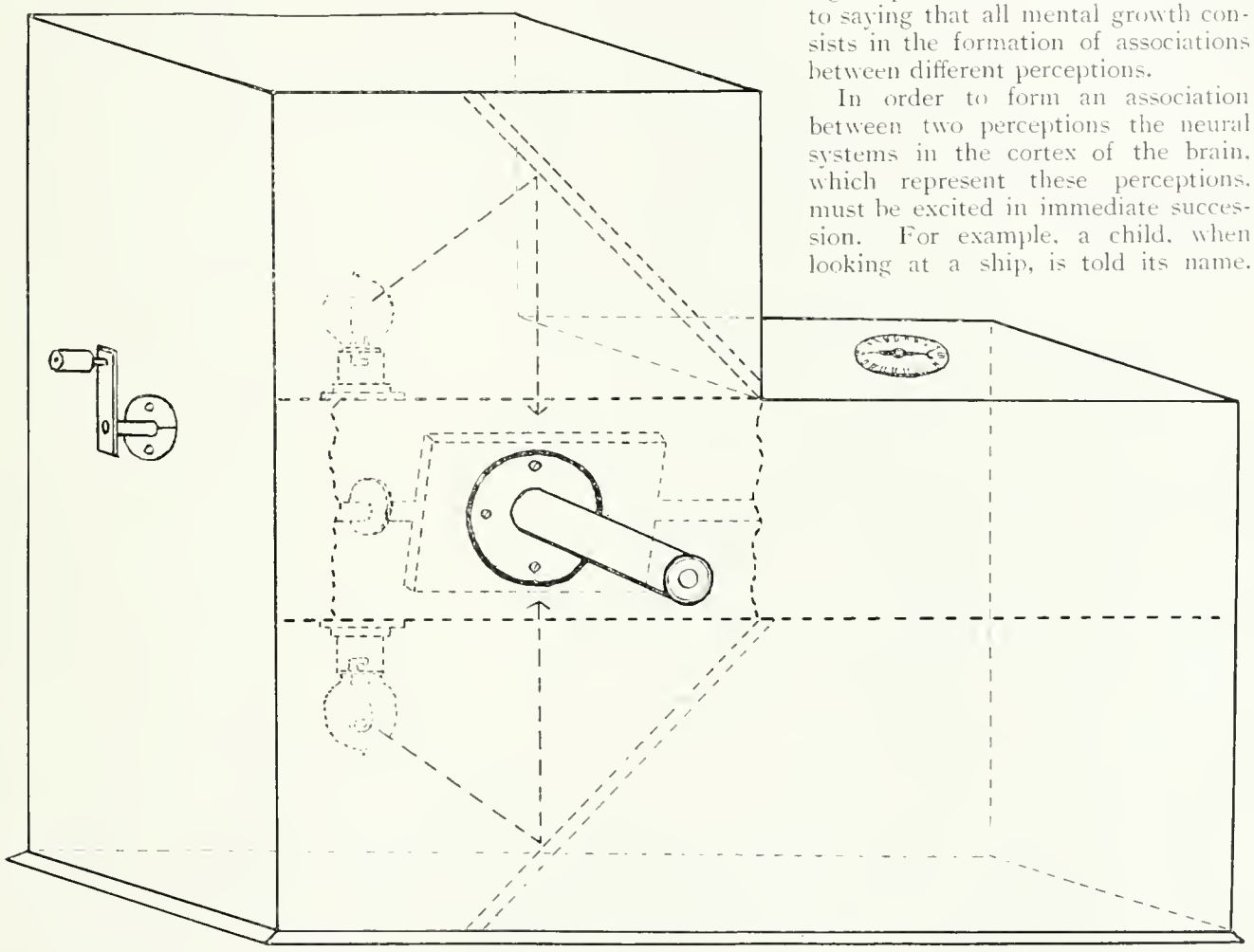


Figure 1. Apparatus for Measuring Perseveration.

The Determination of Mental Character.

This persistence of a colour sensation after the stimulus has stopped, which we have been discussing, is identical, or very closely related to a quality of mind which the psychologists call Perseveration. The amount of this Perseveration is probably a fundamental property of the germ plasm, and, therefore, inherited from our ancestors.

The growth of the mental character of an individual as he passes from childhood to maturity is greatly influenced by the amount of his Perseveration.

Perseveration influences mental growth by the control which it exercises upon the formation of associations between two or more neural systems.

When a nervous impulse passes through a neural track in the brain it reduces the resistance of the track, so that following impulses pass with much greater facility.

This diminution of resistance by the passage of a nervous impulse is called the law of neural habit. According to James, the law of neural habit is the foundation of all mental growth. From the psychological point of view this is equivalent to saying that all mental growth consists in the formation of associations between different perceptions.

In order to form an association between two perceptions the neural systems in the cortex of the brain, which represent these perceptions, must be excited in immediate succession. For example, a child, when looking at a ship, is told its name. The name is ever afterwards associated with the appearance of the ship in the mind of the child.

What has taken place in the brain of the child? The neural system, *a*, representing the visual perception of the ship, was first excited, and immediately afterwards the neural system, *b*, representing the auditory perception of the name of the ship, was excited. The effect of the total operation was to form a path of reduced resistance between *a* and *b*, so that when *a* is next excited a nervous current passes across to *b*, and creates an image of the name of the ship.

According to McDougall's theory, the excitement of *b* exerts a guiding influence upon the discharge from *a*, determining the discharge to take place from *a* to *b*. A physical analogy which helps to explain this phenomenon is the passage of an electric spark from a point at high potential to another point

at low potential. The point at low potential determines the direction in which the spark will leave the point at high potential. The passage of the spark through the air reduces the resistance of its track, though this reduction lasts for a comparatively short time compared with the diminution produced in the neural track connecting *a* and *b* in the cortex of the brain.

The condition, however, to which I wish to direct special attention is that the difference of potential required to form an association track between *a* and *b* is only produced when the wave of excitement passes through *a* immediately before the second wave of excitement passes through *b*. It is necessary also that the excitement of *a* shall be very much reduced before *b* is excited.

The conclusion forced upon us by the above considerations is that anything which retards the rate at which the excitement of a neural system dies out, reduces its power of forming associations with other neural systems. But when once an association, *i.e.*, a track of low conductivity is formed, say, by sufficient repetitions, the nervous currents which flow through the track will last longer.

Now, the property of high persistence, or Perseveration, which we measure by the apparatus described above, will have the effect of retarding the disappearance of the excitement in a neural system.

We should expect, therefore, that persons with high Perseveration would form new associations with great difficulty, and persons with low Perseveration would form them with great ease and rapidity.

Dr. Otto Gross, in his treatise on the Secondary Function, has deduced in a most ingenious way, from this physiological hypothesis, the different kinds of mental character that are likely to arise, from various amounts of the secondary function, or, as we have called it, Perseveration.

From the conclusions arrived at by Gross I have drawn up a scale of Perseveration, and the kind of character likely to be associated with different degrees of Perseveration, in the ordinary conditions of life.

At the centre of the scale we have the average amount of Perseveration, which is associated with the practical common sense of the average man.

When the Perseveration is below the average the speed with which ideas flow through the mind is quickened, and the readiness with which the mind receives external impressions is also increased.

The first category below the average, therefore, contains persons with witty, brilliant, and suggestive minds, persons of great tact, presence of mind, and daring; all of which imply quick response to external stimuli.

To this class would belong the majority of persons who are popularly considered to be geniuses. But if we adopt Carlyle's definition of genius as "an infinite capacity for taking pains," the genius would have to be looked for in the class having Perseveration one degree above the average.

The category with Perseveration one degree above the average contains persons who are fond of abstract thinking, and who follow a theme into all its ramifications. They think slowly and learn slowly. The scope of their consciousness is wide, but they are not quick of apprehension because they do not respond readily to outside stimuli.

We may say, therefore, that the classes with Perseveration one degree below the average and with one degree above the average, produce geniuses of different types, who, while they excel in one direction, have also certain defects associated with their excellent qualities.

When we pass to the classes of persons with Perseveration two degrees above or below the average, these defects are intensified, and serious deterioration of mental character begins to appear.

The category with Perseveration two degrees *below* the average contains persons who cannot keep their thoughts long on one theme; frivolous persons who are fond of superficial associations, such as punsters and cynics; persons to whom all emotions are of equal value and who are consequently of weak moral character; persons who learn anything new very quickly but superficially.

On the other hand, the category with Perseveration two degrees *above* the average contains persons with quite opposite defects. The long duration of the secondary function interferes with the formation of wide associations, and renders the limited associations formed exceedingly stable and inaccessible to outside influences. This corresponds to the person with fixed ideas, apparently founded on sentiment rather than on reason. Gross somewhat invidiously includes in this category vegetarians and anti-vaccinators, but it is preferable to leave the truth of that assertion to be determined by experiment.

When Perseveration falls below, or rises above that of the two categories last described, the mind becomes unstable—we pass from the sane to the insane.

The insanity at the two extreme ends of the scale is of quite different types. Persons with excessively low Perseveration are liable to *acute mania*, and persons with excessively high Perseveration usually suffer from *melancholia*.

The symptoms of these two classes of the insane are deducible by Gross's hypothesis from the influence of excessively low or excessively high Perseveration on the formation and action of the mind.

A considerable number of persons of both sexes have been measured with the revolving mirror apparatus, in the Anthropometric Bureau at the Japan-British Exhibition.

Though the whole of the data obtained have not yet been analysed, the following are some of the results obtained from the measurement of eighty-two men and twenty-six women.

Comparison of the Perseveration of the Two Sexes.

The first question I set out to determine was whether there was any significant difference between the average Perseveration of the two sexes.

I found that the mean Perseveration of the eighty-two men was 153·6 units; while the mean of

the twenty-six women was 138·6 of the same units.

This amounts to a difference of fifteen units between the average Perseveration of the two sexes. The standard deviations of the two groups, namely, 27·9 and 33·3, having been calculated, it is easy to show that the odds in favour of the two groups being significantly different in Perseveration are 53 to 1: odds which to most people will be enough to prove it, though there is reason to believe that these odds would be greatly increased if we had larger numbers.

We arrive, therefore, at this important conclusion —that the average Perseveration of Women is significantly less than that of Men.

This lower Perseveration of Women we should expect to be associated with the mental characters indicated on our scale, i.e., we should expect in Women greater quickness of apprehension, tact and presence of mind than in Men, with a diminution of those good qualities which are associated with high Perseveration. This, I think, agrees pretty well with general experience.

Some years ago Miss Thompson made a number of psychological tests on men and women students in America, and could find, I believe, no significant difference between the mental characters of the two sexes. Perseveration appears to be one of the characters in which there is a real difference.

Comparison of Perseveration of Light and Dark Haired Persons.

The next point I endeavoured to determine was whether there was any real difference between the Perseveration of Light and of Dark haired persons.

Hair colour being a very valuable criterion of Race in northern Europe, we might expect to decide from the results obtained the difference between the characters of the fair Anglo-Saxon element and the dark Mediterranean element, in the population of the British Isles.

The hair colours were classified in two categories, namely, light, including fair and light brown; and dark, including dark brown and black.

I find from my figures that the average Perseveration is as follows:—

Light-haired persons	...	154·5
Dark-haired ,,	...	150·1

This suggests that the Anglo-Saxon race has somewhat higher Perseveration than the dark Iberian, or Mediterranean, race, and the mental characters associated with the various degrees of Perseveration that are to be expected in these races.

Many other interesting correlations between the physical and mental characters of man might be worked out from such data as we have collected at the Anthropometric Bureau: but I await larger numbers before undertaking the labour of further statistical calculations.

These results, however, as far as they go, are sufficient to show how vastly our knowledge of the laws of the Evolution and the education of man would be increased by the collection of extensive statistics of mental as well as physical measurements.

Perseveration and Colour Blindness.

It has already been mentioned that when a person is colour blind, his persistence for the colour to which he is blind is always much higher than in persons with normal colour vision.

Does the presence of colour blindness vitiate the measurement of Perseveration by the revolving mirror apparatus? I think not. The alternative conclusion is, I believe, the correct one, namely, that colour blind persons have always high Perseveration.

The few cases of known colour blind persons that I have dealt with support this conclusion.

The following hypothesis also leads to the conclusion that high Perseveration and colour blindness are both manifestations of the same fundamental property of the neural material of the brain.

Let us suppose that a nervous current is analogous to an oscillating electric current in a conductor with self induction and resistance. When the force which maintains such electric waves ceases, the waves do not immediately cease but persist for a time, depending, *inter alia*, upon the resistance. The greater the resistance the quicker the waves die out, or the greater the conductivity the longer they persist.

The experiments of Shelford Bidwell show that the persistence of a visual sensation is similar to that of electric waves. He has detected the presence of a series of waves of decreasing amplitude.*

High Perseveration would appear, therefore, to be analogous to high conductivity in the neural systems.

The nervous system of the human body may be described generally as consisting of three circuits arranged in parallel. Nervous currents passing through the lowest circuit, at the spinal level, produce no sensation: those passing through the intermediate circuit produce sensations: and those through the highest circuit produce perceptions.

If, now, the conductivity of the lowest circuit is so high as to drain off practically the whole of the current from the two higher circuits, there will be neither sensation nor perception produced by this particular current, though its amount may be equal, or even greater than currents which do produce sensations.

According to this hypothesis, a person would be colour blind to red when the sensation producing circuit was short circuited by the high conductivity of the lowest circuit.

As the whole nervous material of the body has a common origin in a specific section of the germ, we may suppose that its composition is fairly uniform. High conductivity of one part of the nervous system as indicated by colour blindness, makes it probable that the average conductivity of the whole nervous system will be high. And it follows from this that persistence or Perseveration generally will be high, with all the consequences on the ultimate mental character which I have endeavoured to explain above.

* Curiosities of Light and Vision, p. 186.

THORVALD NICOLAI THIELE.

By F. A. BELLAMY, Hon. M.A., F.R.A.S.

THIELE was born on December 24th, 1838, in Copenhagen, and was a scion of a respected and well-educated family. He shewed, very early in life, distinct talents for the mathematical profession, and kept himself abreast of the mathematical progress of his time. His tutor in Astronomy was d'Arrest, and he obtained his Master's degree in 1860, about which time he accompanied d'Arrest to Spain, to observe the total eclipse of the sun. In 1866 he gave his inaugural dissertation, and discussed the relative motions of the double star γ Virginis: this was published in Danish, and filled one hundred pages.

Thorvald Nicolai Thiele.

In 1870 he turned his attention to another department of applied mathematics which interested him, the problems of life assurance. His work in this subject was first directed to the difficult problem of the adjustment or settlement of the mortality tables; into this Thiele penetrated very deeply, and was doubtless one of the earliest explorers in this subject.

As a recognition of this scientific work he had the honour of being elected a foreign member of the Institute of Actuaries in London; while in Denmark he had great influence, and held a position of great importance as Chairman of "Foreningen af danske Aktuarer," and was Director of the Life Assurance Society "Hafnia," from 1872.

Of his other works mention must be made of the "Theory of Observations," which was printed in English at Copenhagen, and published in London in 1903; and of "Interpolations rechnung." Through the impulse which he had given to the subject of the numerical researches concerning some periodic solutions of a special case of the problem of three bodies, Thiele rendered an acknowledged service to Astronomy, both of great and general value. His love for double-star astronomy was continued throughout his life; and attention may be drawn to Otto Struve's criticism on the determination of the systematic errors of double-star observations in the *Vierteljahrschrift der Astronomische Gesellschaft* (Leipsic) for 1880.

Besides these publications he contributed many notes, articles, and memoirs to the current scientific journals of his day. Most of his astronomical contributions were sent to the *Astronomische Nachrichten* and commenced as far back as 1859 at the age of twenty, when he wrote upon the double stars ξ Librae, Castor, and upon Sun-spots: in 1860 a note on the Eclipse of the Sun; and in 1861 a paper on the Latitude of the Observatory at Copenhagen appeared.

From that time we find he contributed to science papers of more or less importance in several branches of Astronomy, and mention may be made of those upon Double-star Orbits—where he proposed new methods: a Geometrical Problem in Theoretical Astronomy: Longitude between Lund and Copenhagen (with Dunér): Orbits and Ephemerides of Minor Planets: Quasi Errors of Least Square Method: Bahnberegning for Planetes vid en modification af de Kepplerske lore: On some Interpolation Formulae for Double-Stars (*Copernicus* II. p. 25–41)—this gives six methods of using the observations, and tables are furnished to assist the calculations: also he wrote obituary notices of Schjellerup and Svedstrup. His important and concise paper on the motion of the Double-Star Castor was carefully written, in French, and is evidence of a wide grasp of that particular subject and extensive reading; it formed one of the communications made in 1879, when the four hundredth anniversary of the formation of the University at Copenhagen by Christian I. in 1459, was celebrated.

Thiele was an eminently gifted man. The extent of his reading and the range of subjects which interested him was in a great degree exhibited in a marked manner when lecturing to his audiences: but, though Thiele probably excited some enthusiasm among his scholars, he had not in a high degree that influence in university teaching which one might have expected from a man of his talents. He was of a neat and engaging appearance, and, although he was of a reserved or retiring disposition, it was not easy to consult or approach him with questions, but he was always a true friend to those who succeeded in doing so. He was no mean linguist, and as evidence of his powers the papers just referred to were written in one or other of these languages—Latin, Danish, German, French or English.

Thiele was appointed a Professor in the University of Copenhagen and Director of the Observatory, which was re-built and re-organised in the early period of his predecessor's reign (d'Arrest), in October of 1875: he retired as Emeritus Professor a few years ago and was succeeded by Strömgen.

The writer is indebted to Herr C. Burran's biographical notice for some of the information given, and to the *Astronomische Gesellschaft* (Leipsic) for permission to reproduce the portrait.

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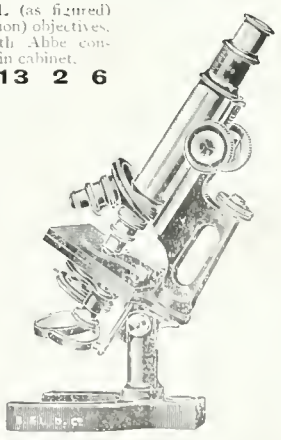

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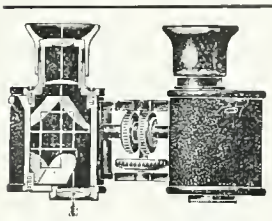

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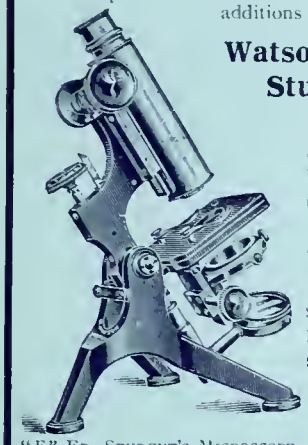

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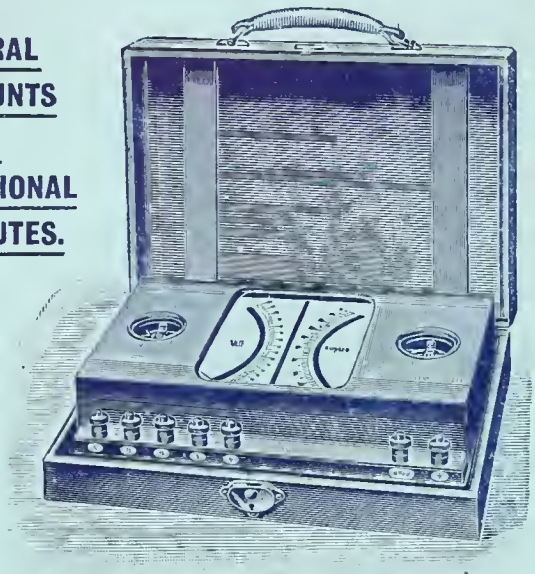

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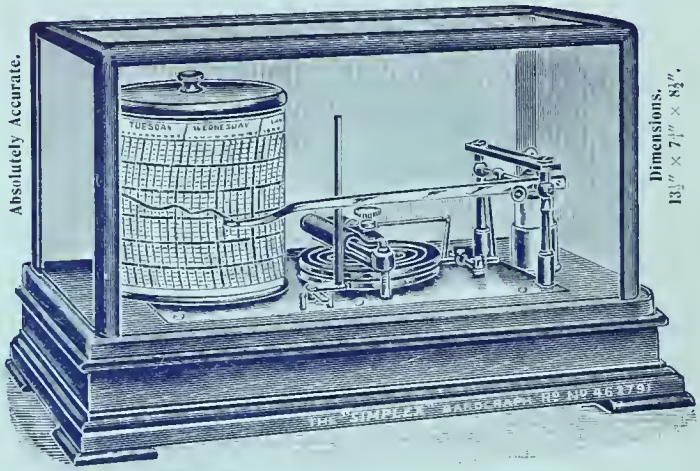

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